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THE ORIGIN OF THE MAMMALS.

SPECULATIONS as to the origin of the various existing groups of animals and plants are always dangerous, and yet they have for many a certain fascination. They partake, somewhat, of the nature of an algebraic problem in that there are unknown quantities to be discovered, but they differ from any such soluble problem in that we have not equations enough to allow us accurately to ascertain the values of x, y, z and the like. Here is a chance for the play of the imagination and a chance for close guessing at the values of some of the unknown elements. Different students have assigned different values to them, and hence the varying character of the answers we have had given to us. Recall the different forms which we have been asked to consider as ancestral to the vertebrates—cœlenterates, nemertines, annelids, *Phoronis*, crustacea, arachnids, tunicates, *Balanoglossus!* Certainly there has been some error in the assignment of values to the unknown to produce such discordant results as these.

Yet these speculations have a certain value; they call attention to problems, they suggest lines of research, they are exercises of the logical powers. One of these genealogical problems is that which deals with the origin of the mammals. It has been twice 'settled,' and yet there is some new evidence, and there are new points of view.

Until 1884 the general opinion among those who speculated on phylogenetic matters was that the group of mammals had an amphibian ancestry. Huxley was especially prominent in advocating such a line of descent, basing his conclusions upon the naked, scaleless skin, the double occipital condyle and other cranial features, some of which will be mentioned later. Yet this view was not universal, since Owen, in 1876, and Cope, in 1878 and in later papers, had suggested a reptilian ancestry for the group. Still, these speculations attracted but little attention until 1884, when Caldwell's famous dispatch, 'Monotremes oviparous, eggs meroblastic,' excited the enthusiasm of the British Association for the Advancement of Science, then meeting in Montreal. At that date embryology was the ruling force in deciding questions of phylogeny, and the discovery by Caldwell that the *Echidna* laid eggs, and that these eggs were like those of the reptiles rather than those of the amphibia in their segmentation, at once suggested to every zoologist a reptilian ancestry for the mammals. This was still further emphasized a few days later by Cope's paper upon the relations of the theriomorphous reptilia and the monotreme mammalia, read before the American Association at its Philadelphia meeting.

Since that day numerous students have built upon that foundation, and I need but allude to the papers of Cope, Seeley, Osborn, Howes, Lyddeker, Baur and Case, all of which accept the reptiles as the progenitors of the scaleless, hairy, milk-producing vertebrates that we know as mammals. They have brought forward much evidence—but solely osteological in character—in support of their views, and for the summary of this which follows I am largely indebted to the able papers of Osborn.

The particular group of reptiles which they have selected for this high honor is that known as Theriomorphs, the fossils of which are found in rocks of Permian and Liassic age in Illinois, Texas, New Mexico, Scotland, Bavaria, Bohemia, the Urals, Bengal and South Africa. Then they suddenly disappear, for no traces of them occur in rocks of more recent age, and there is a vast gap between them and the earliest mammals of which we have any adequate knowledge. This group shows several features in which they approach the mammalia more closely than do any other reptiles, and a summary of these points may be of value now.

In the mammalia the skull is articulated to the atlas, the first bone of the vertebral column, by a pair of oval articular surfaces, the occipital condyles. These are borne one on each exoccipital bone. In most reptiles, on the other hand, there is but a single condyle, largely or wholly basioccipital in origin. In many of these theriomorphs the exoccipitals partake in the formation of this structure, and in some the basioccipital portion exhibits a tendency to recede, thus exhibiting a condition which, carried still farther, would result in two condyles like those of the mammals.

In the mammals there is a heterodont dentition; that is, there are different kinds of teeth—incisors, canines and molars. In recent reptiles and in amphibia there is no such differentiation, but in these theriomorphs one group presents a dentition which is strikingly suggestive of that of the mammals. Indeed, one species, described from a lower jaw, was at first regarded as a mammal.

In the mammals the anterior dorsal ribs bear peculiar relations to the vertebræ. These ribs bear two 'heads,' by which they are articulated with the backbone. One of these, the so-called tubercular head, articulates with a process, the diapophysis, which arises from the neural arch, while the other, or capitular head, has its articulation with

the bodies or centra of two vertebræ, in such a way as to suggest that its proper place was between them; that is, intercentral in position. This condition has led Cope and others to the view that a vertebral element, the intercentrum, once existed here as it does in many lower vertebrates, and that the rib formerly articulated with this. By the disappearance of this intercentrum the mammalian relations have been brought about. In some of the theriomorphous reptiles the capitular head is also intercentral.

In many mammals there is a small hole, with the disproportionately large name of entepicondylar foramen, in the inner lower end of the humerus, the bone of the upper arm. This opening is for the passage of the brachial artery and the median nerve. In the lower vertebrates such a foramen is unknown, except in the theriomorphs.

Again, in the mammals the lower jaw articulates directly with the cranium by means of a shallow pit, the glenoid fossa, on the ventral surface of the squamosal portion of the temporal bone, no other element intervening between the two. In most of the lower vertebrates the lower jaw does not articulate direct with the cranium, but a movable bone, the quadrate, is inserted between them, and forms a suspensor

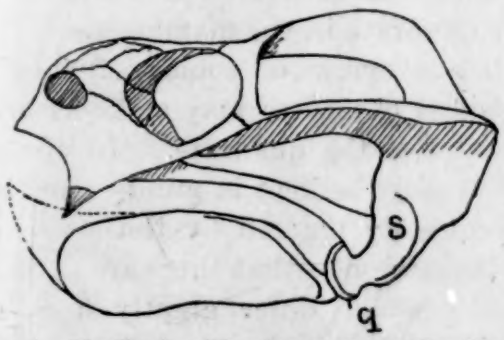

FIG. A. Skull of a Theriomorphous Reptile (*Gordonia*). Showing the quadrate bone (*q*) firmly united to the enlarged squamosal (*s*). After Newton.

of the lower jaw. In the theriomorphs and crocodiles the quadrate is fixed and immovable, and is held in position by a second bone, the squamosal, which, together with the quadrate, takes part in the formation of the articulation of the lower jaw. Now, say the advocates of the reptilian ancestry of the mammals, if the quadrate were to become completely fused with the squamosal, the result would give a condition from which the mammalian articulation could readily be derived. In support of this view, they cite the case of a human skull, described by Albrecht, in which a separate bone, which he interpreted as the quadrate, appeared in this very region.

Further evidence, which is regarded as pointing in this same direction of a theriomorphous ancestry, is furnished by the pelvis, while the imperfectly known tarsal bones of these reptiles are doubtfully interpreted as supporting the same view. These features, however, are of secondary importance in comparison with those already enumerated, for the peculiarities of the mammalian pelvis and tarsus are as readily derived from the amphibia as from the theriomorphs. The foregoing enumerates the chief osteological evidence for the reptilian ancestry of the mammals. The only other evidence recalled at present which points in the same direction is the character of the segmentation of the monotreme egg, already alluded to.

Within more recent years there has been a tendency upon the part of some zoologists to return to the support of an amphibian parentage of the mammals. Klaatsch, Maurer, Hubrecht and Beddard have pointed out features of the soft parts of mammals, which are more easily interpreted by this assumption; but, of course, this cannot be conclusive, for we can know nothing of these structures in the theriomorphs. Hence this evidence, which will be summarized later, can only be regarded as cumulative and not of first importanee.

The osteological facts which have already been enumerated need analysis, for it is

possible that they will bear another interpretation than that usually accorded them.

The argument from the heterodont dentition can have but moderate value, for we know that different types of teeth have been developed independently in different groups of vertebrates, and it is possible that they could have arisen in the mammals and not have been inherited from the theriomorphs. So, too, with the entepicondylar foramen. The nerve and blood vessels exist in lower forms, and it is conceivable that the existence of the foramen in the two groups may be explained upon the ground of homoplassy and without implying inheritance. This foramen certainly is of too little importance to be used as the basis of great speculations.

The matter of the ribs is more important. In the amphibia with bicipital ribs, the capitular head rests upon the so-called centrum, and not between two centra, as in theriomorphs and mammals. Yet, with our present knowledge, this is far from conclusive, for we know almost nothing of the morphology of the vertebræ in most groups of vertebrates. The researches of Fritsch upon the fossil stegocephalan amphibia have shown that the vertebral centra are by no means simple affairs, but are really composed of several (at least five) separate elements. Traces of at least some of these, more or less distinct, appear in the higher vertebrates; but until the homologies of these are worked out for the existing amphibia, the reptiles and the mammals, arguments based upon the relations of the ribs to centra and intercentra must remain inconclusive. As it stands at present, it must be admitted that the burden of proof, so far as the ribs are concerned, is against the advocates of amphibian ancestry.

The matter of the occipital condyles is even less conclusive. Until the discovery of the theriomorphs, the fact that both amphibia and mammals have two condyles and the sauropsida but one condyle, was regarded by Huxley as the very strongest argument for amphibian ancestry, and the most that is claimed for the double condyles of the theriomorphs is that they show that these animals are not to be counted out upon reasons based upon the articulation between cranium and vertebral column.

Yet in none of these is there an exact reproduction of the mammalian conditions, for in all the basioccipital participates to a greater or less extent in the formation of the condyles, these structures being described at times as distinctly bilobed, at times having the basioccipital portion receded below the level of the rest, but still rather prominent. In other words, the double condylar condition of the theriomorphs—and hence that of the mammals—is supposed to have arisen from the single condyle of other forms by recession of the basi-occipital. In the development of the mammals there are, however, no traces of such a stage. All this, however, is aside from the more fundamental question, Is the occipital region of the skull homologous throughout the vertebrates?

Of far more importance than all these features is the problem of the quadrate. In fact, the whole matter of the ancestry of the mammals may almost be said to hinge upon the decision arrived at as to the fate of the quadrate in the mammals.

A brief review of some points of an anatomical character may make clear the discussion of the quadrate. In the first place, it must be kept in mind—and this is too frequently ignored by those who deal with bones alone—that there are two kinds of bones which differ greatly from each other in history, both ontogenetic and phylogenetic, and that while one may seemingly replace the other, there is no evidence whatever of one passing into the other. These two types are known respectively as cartilage bones and membrane bones. A

cartilage bone is always preformed in the peculiar substance known as cartilage, and in this only later is the chondrin matrix replaced by salts of lime. Membrane bones, on the other hand, never have a cartilage stage. They arise by the direct ossification of connective tissue membranes. Further, investigations seem to show that there may be at least two types of membrane bone, one of which, exemplified by most of the membrane bones of the skull and by the bony plates of the alligator, has arisen by the fusion of the bases of dermal scales or teeth, and the sinking of these to a deeper position. The other type, familiar in the kneepan and the bony strands so well known in the drumstick of the turkey, arises from the ossification of tendons.

In the sharks the skeleton of the jaws arises from a continuous stroma or anlage on either side of the head. Each of these strands—known as the mandibular arch—becomes interrupted in the middle as it becomes converted into cartilage. The upper half of each arch forms the upper jaw—the pterygo-quadrate of anatomy, while the lower half in a similar way gives rise to Meckel's cartilage, the skeleton of the lower jaw. These jaws do not articulate directly with the cranium, but the pterygo-quadrate is suspended in front by ligaments, while behind, besides a ligament, the upper half of the next or hyoid arch intervenes as a hyomandibular element between the jaws and the cranial wall, thus forming a suspensorium for these parts.

In the teleosts, or bony fishes, where bone largely replaces cartilage in the adult, the hyomandibular still acts as a suspensor, while the pterygo-quadrate, relieved of its functions as the upper jaw, ossifies in two portions; in front, as a pterygoid bone; behind as a smaller element, the quadrate. The quadrate articulates, on the one hand, with the hyomandibular; on the other, it supports the Meckelian, the hinge of the lower jaw being formed by the articulation of Meckel's cartilage with the quadrate.

In the vertebrates higher than the fishes the hyomandibular disappears as a suspensor, and it is not to be recognized with absolute certainty in this region. As will be seen shortly, there is some evidence that it is not entirely lost, but persists with changed functions. In contrast to what obtains in the fishes, in amphibia, reptiles and birds, the quadrate articulates directly with the cranium in the region of the ear, and forms a suspensor for the lower jaw. In its history in all these groups the quadrate is preformed in cartilage, and hence, when it ossifies, it becomes converted into cartilage bone. In amphibia, reptiles and birds in the embryonic stages, the Meckelian cartilage, of course, articulates with the quadrate, but when the definitive lower jaw is formed, some features are introduced which must be described. In all the bony vertebrates the Meckelian does not furnish the bones of the lower jaw, but these arise as membrane bones arranged round the cartilage bar. In the amphibia and reptiles the most constant of these bones is a very large, tooth-bearing dentary in front, extending backwards on the outer side of the Meckelian. Further back, on the inner side, is a smaller bone, the splenial, which also may bear teeth. The third of these is the angular, which is placed behind those already mentioned on the lower and inner sides of the proximal end of Meckel's cartilage. The Meckelian ossifies only at its posterior end, where it articulates with the quadrate, giving rise at this point to a cartilage bone, the articular. In short, the lower jaw consists of a single cartilage bone, the articular, and three or more membrane bones.

The articular surface of quadrate and articular presents features which must be mentioned. In all the non-mammalian groups the quadrate has a rounded or some-

what semi-cylindrical surface which fits into a corresponding groove or cavity in the articular.

Another set of bones may be mentioned now. These are the bones of the middle ear, the ossicula auditus of anatomists. It seems probable that the sense of hearing appears in the vertebrates only with the assumption of a terrestrial life, and that the so-called ears of the fishes are organs for the maintenance of equilibrium. In the amphibia, then, true hearing appears. In the salamanders an opening occurs in that part of the cranium which surrounds the inner ear. This opening is the fenestra ovale, and is partly closed by a small cartilage or cartilage bone, the stapes, possibly to be homologized with the hyomandibular already referred to as apparently lacking in the non-piscine vertebrates. This interpretation receives some confirmation from the fact that in several salamanders the stapes articulates with the quadrate, a point which is of importance when we come to a consideration of mammalian structures.

In the frogs, reptiles and birds the stapes is a long slender rod,* frequently called the columella, and is in no way connected with

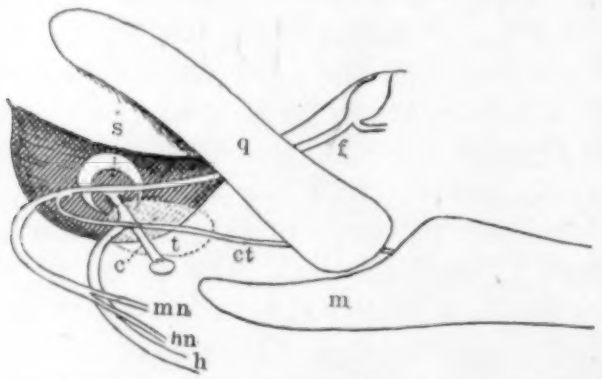

Fig. B. Diagram of Ear Region in a Lizard. *s*, stapes; *c*, columella; *q*, quadrate; *m*, lower jaw; *ct*, chorda tympani nerve.

the quadrate. It rather extends straight outwards from the fenestra ovale, across the cavity of the tympanum, or middle ear, to reach the tympanic membrane. It thus becomes a sound-conducting apparatus, conveying the sound waves across the tympanum to the inner ear. This columella arises in the posterior wall of the tympanum, and, although it later moves forward into the tympanum, must consequently be regarded as a structure belonging to the post-tympanic region.

In the mammals, on the other hand, the sound-conducting apparatus is greatly different. Instead of a columella there is a chain of three bones leading from the fenestra ovale to the tympanic membrane. These are called, in order from within out, the stapes or stirrup bone, incus or anvil, and malleus or hammer, the stapes being situated in the fenestra ovale, the malleus being connected with the tympanic membrane and the incus intervening between these two. Many attempts have been made to homologize these bones with the columella of lower forms, but none of these attempts have been successful, and it is probable that complete homology does not exist. This is shown almost conclusively by two facts of anatomical relationship. In the first place, the middle member of the mammalian chain—the incus—arises in front of the tympanic cavity, and hence cannot correspond to any part of the columella, which, as we have seen, is post-tympanic in origin. Again, the incus lies in front of that branch of the seventh or facial nerve which is known as the chorda tympani, while the columella lies behind it. Now, nerves are older structures than skeletal elements, and any cartilage or bone placed in front of a major branch of a nerve cannot be homologized with a skeletal element lying behind the same nerve in another vertebrate.

Now, if these ear bones of the mammals are not homologous throughout with the columella, with what structures in the lower vertebrates can they be compared?

* The columella is more than stapes, but for present purposes the details are not necessary.

Here embryology comes in to assist. The development of these bones has been followed by many, and it is a rather significant fact that while the embryologists are in substantial agreement in their interpretations, their opinions are at variance with those of the students who have attacked the problem from the standpoint of adult structure. Now, since the embryologists have the wider view, the larger basis of facts at command, on *a priori* grounds their conclusions should be given the greater weight. Embryology plus comparative anatomy certainly forms a better basis for conclusions than comparative anatomy alone.

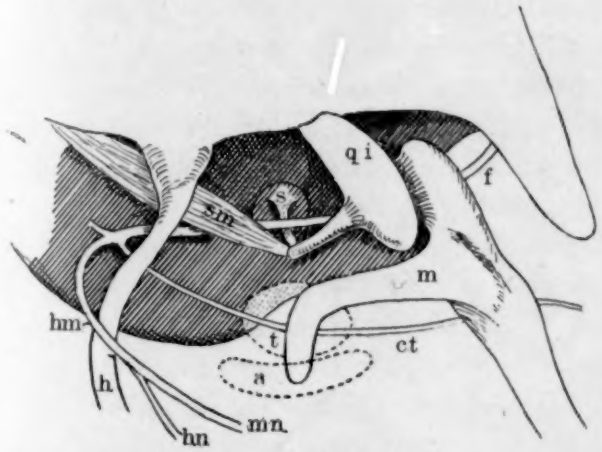

FIG. C. Diagram of the Ear Region in a Mammal. *s*, stapes; *i*, incus; *m*, malleus; *ct*, chorda tympani nerve.

In the embryonic mammal, before the appearance of cartilage, a strand of denser mesenchyme extends from the point where the anlage of the stapes can be recognized into the lower jaw. Position and relationships show that this strand is the first appearance of the mandibular arch. With the formation of cartilage this arch becomes divided into a proximal portion, which can be traced, step by step, until it develops into the incus and a more distal portion, which is as clearly Meckel's cartilage, extending into the lower jaw. This incus soon develops an articular surface for connection with the stapes, while a second set of surfaces is found between the incus and the proximal end of the Meckelian cartilage. The incudal surface of this last is convex, while the corresponding articular surface on Meckel's cartilage is concave. It follows from these facts of development and structure, as well as from others which cannot be detailed here, that the incus fulfills, in the embryonic stages, every condition demanded for the quadrate, while the great size of these elements in the early condition can only be interpreted as indicative of some function in their ancestral history different from that of a sound-conducting apparatus. Again, it is a matter of no little importance in what will follow, that this quadrate articulates with the stapes just as in many urodele amphibia, while such relationships are unknown in any reptile, living or fossil. In the third place, this incus for a time articulates directly with the skull, just as does the quadrate in the lower forms, a condition not easily explicable upon any other view than that regarding this as the quadrate.

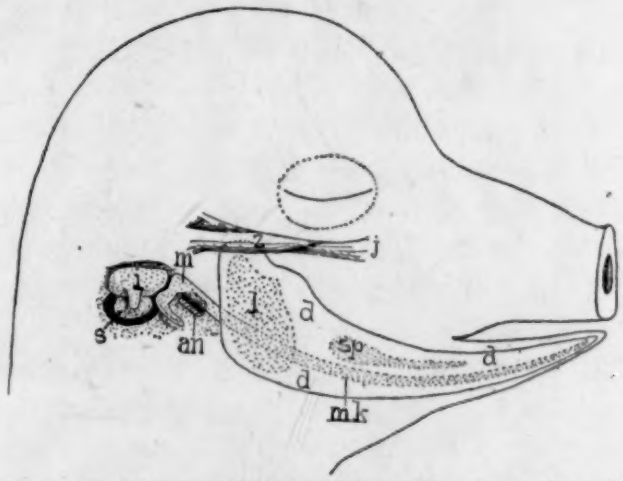

FIG. D. Diagram of the Ear and Lower Jaw in the Pig. *an*, angulare; *d*, dentary; *i*, incus; *j*, jugal; *l*, cartilage of articular region of lower jaw; *m*, malleus; *mk*, Meckelian cartilage; *s*, stapes; *sp*, splenial; *z*, zygomatic process of temporal—the letter lies just in front of the glenoid fossa.

The malleus is largely formed by the ossification of the proximal end of Meckel's cartilage, and this fact, together with every

other relation except one to be mentioned immediately, goes to prove that it is the equivalent of the articular. In the formation of the malleus a membrane bone is concerned. This arises in front of the articular proper on the inner and lower side of the cartilage—that is, in the right position for the angular—and forms the process Folianus of the malleus. At some distance from the malleus two membrane bones form the lower jaw of the adult. The larger of these, from its relations and position, is clearly the dentary, while the smaller and inner one is as plainly the splenial. Thus we can apparently recognize in the mammalian lower jaw the articular and the three membrane bones most constant in the lower vertebrates. In some mammals, according to Parker, two additional membrane bones, each with its equivalent in the lower vertebrates, are said to occur. Besides all these there exists a patch of cartilage in either half of the lower jaw which arises entirely independently of the Meckelian, never unites with it, and which is, so far as I know, without any equivalent in any amphibian, reptile or bird.

To the identification of the bones of the lower jaw which have just been given, there is one very serious objection. The articulation with the cranium is not homologous with that of the lower vertebrates. After the formation of all the bones of the jaw the Meckelian cartilage becomes absorbed between the Folian process and the hinder margin of the dentary, leaving the jaw proper without connection with the quadrate. The posterior portion of the dentary extends up around the second cartilage mentioned, and articulates with the squamosal, the dentary furnishing the articular condyle, the squamosal the glenoid fossa. It is not easy to say how this new articulation can have been introduced, for it is hard to see how an organ in constant use like the jaw could transfer its hinge from the quadrate to the squamosal. And yet, from any point of view, it seems impossible to escape the conclusion that it is not homologous with the articulation of the lower vertebrates, for the articulation in the non-mammalian forms is at the proximal end of Meckel's cartilage, while in the mammals the Meckelian does not come anywhere near the region of the glenoid fossa. Again, in the glenoid fossa there is no trace of any cartilage which could be used as a basis for the view that the quadrate has disappeared at this point.

A word about Albrecht's supposed quadrate may be inserted here, since it has often been quoted in this connection. Albrecht found, on one side of the skull of an idiot, a separate bone in the region of the zygomatic process of the temporal bone, and since the lower jaw articulates at this point, he at once jumped to the conclusion that this bone must be the missing quadrate. Now, the fact that cartilage is unknown in this region would at once negative any such conclusion, while the further fact that the skull in question was that of an imbecile and the additional bone occurred on one side only, is certainly suggestive. No history of the case was given, but it is not beyond the bounds of possibility that an injury to the head may, at the same time, have caused the imbecility and have produced the supernumerary bone, upon which, as a very slender basis, a considerable superstructure of speculation has been built.

There is one series of facts which may possibly lead to an explanation of this change in point of articulation. In certain sharks there occur labial cartilages which lie outside of the jaws and perfectly free from them. Now, the cartilage mentioned above as occurring in connection with the dentary bone of mammals, occupies the position of one of the lower of these labial cartilages—Parker has, indeed, identified

it as a labial—and this has apparently been concerned in the transferrence of the hinge of the lower jaw. This, however, is mentioned only as a suggestion; details have yet to be worked out, and further study may show that this view is untenable.

Now, summing up the evidence of the bones, we may say that the characteristics of the ribs, the heterodont dentition, and the entepicondylar foramen point more strongly towards a reptilian rather than towards an amphibian ancestry for the mammals. On the other hand, the occipital condyles are even stronger evidence in the other direction. But, when we consider the relations of the ear bones and the quadrate, the weight of argument is very strongly opposed to a reptilian ancestry, while these same relations, and especially the articulation of the quadrate with the stapes, go far towards supporting the theory that the mammals have descended from the amphibia.

There is another series of osteological facts which also seems to point in the same direction. In the mammals, as in the amphibia, the ankle joint is formed between the bones of the shank (tibia and fibula) and the proximal row of tarsal bones. In all reptiles of which we have adequate knowledge, the joint is between the proximal and distal rows of tarsal bones—is intratarsal. This, however, is not conclusive, since the foot structure of the theriomorphs is very imperfectly known.

Besides the osteological evidence for the descent of the mammalia from amphibian-like forms, there are facts derived from the soft parts which have a cumulative value. They, however, are not conclusive, for we cannot say what may have been the relations in the theriomorphs. It may be that these extinct reptiles possessed one or all of these features, but the fact that they are lacking in all modern reptiles lends plausibility to the view that they were absent from the older members of the group. A detailed account of these would far transcend the limits of this paper, and but the briefest mention can be made of them.

In the first place, mammals are strongly marked off from all other vertebrates by the existence of hair. For a long time it was thought that hair, feathers and scales were homologous structures, but Maurer has shown that hair is totally different from the others. It is true that Weber has criticised Maurer, but his criticisms seem far from conclusive. According to Maurer—and he offers a large mass of facts in support of his contention—the only structures in the lower vertebrates which can be conceived to have given rise to hair are lateral-line organs of the amphibian type. Now, lateral-line organs are unknown in any terrestrial form. Even in the frogs and salamanders they are lost during the metamorphosis which precedes a life on land. Hence it is very probable that they were lacking in the theriomorphs, all of which were apparently terrestrial in habit.

The student should also read Klaatsch's account of the mesenterial structures, especially of the superior mesenteric artery, to see how impossible it is to derive the relations of these from any known condition in the reptiles. In the mammals these structures are far more primitive than in the reptiles, and Klaatsch concludes that their origins must be sought in forms below the existing amphibia.

Mammals alone have well-developed external ears, and these, as well as the tube leading to the drum—the external meatus—are supported by cartilages. All who have worked at these agree that they must have been derived from opercular structures, like those of fishes, supported by the hyoid arch. Now, all such structures are absent from all known reptiles, nor do we know of them in the amphibia. They must be sought in

forms between the fishes and the stegocephali.

The thoracic duct of the mammals is the primitive lymphatic duct of the left side; that of the right is greatly reduced and receives no lymph from the lower part of the body. Exactly the same conditions occur in the urodeles, but not in the reptiles.

Another item of interest in this connection is that mammals and amphibia get rid of their nitrogenous waste in the form of urea, while reptiles void uric acid.

As we saw earlier, embryology was an important factor in directing attention to the reptiles as ancestors of the mammals, but now the weight of its evidence is in the opposite direction. The fact that the monotreme eggs are meroblastic is far from conclusive, since similar conditions have arisen independently several times in the animal kingdom. Hubrecht, however, has pointed out that certain other features of development — those connected with the fœtal envelopes of the mammals—are not to be derived from the conditions known in any reptile, but that they are easily explained as arising from a type of egg found in the amphibia. As these arguments, so far as I am aware, have not been summarized in English, they may be given in a brief form here, omitting all points which have no immediate bearing upon the question at issue, such as the two types of fœtal circulation, the nutritive functions of the trophoblast and the like.

As is well known, the mammals, like the sauropsida, form a fœtal envelope, continuous with the sides of the body—known as the amnion; and from the fact that the sauropsida are lower than the mammals, the natural view has been that the reptilian type has been the ancestral one, from which that of the mammals has been derived. Were this envelope to arise in all mammals in the same way that it does, for instance, in the sheep or the rabbit, this conclusion could not be gainsaid; but when the amnion of the guinea-pig, the hedgehog, the flying fox and that of man are considered, we meet conditions which it is extremely difficult, if not impossible, to explain in such a way.

Forget for the moment the well-known diagrams of amnion formation which appear in any text-book, for they will confuse. In the hedgehog there arises very early in development a two-layered vesicle, the layers being, according to Hubrecht's interpretation, ectoderm and entoderm. At one end of the vesicle the ectoderm is much thicker than elsewhere, and projects like a cone or papilla into the central cavity. Soon a splitting occurs in this ectodermic thickening, so that the whole structure now forms a double vesicle, its two cavities being separated by a partition formed of ectoderm and entoderm, the larger and older cavity having walls of ectoderm and entoderm, the later one walls of ectoderm alone. From this partition the embryo will arise.

There are now clearly two kinds of ectoderm present in the germ; one the embryonic, the other forming the outer walls of both vesicles. For this latter Hubrecht has proposed the name trophoblast in allusion to its nutritive functions, and he distinguishes two kinds or regions of trophoblast; that of the smaller cavity being called the allantoidan, that of the larger the omphalidian trophoblast, from their future relations to allantoic and vitelline circulations.

With the development of the mesoderm, which, of course, arises between the ectoderm and entoderm of the germinal area, an important change is introduced. The somatic sheet of this layer grows outward and then turns upward into the angle between the embryonic ectoderm and the omphalidian trophoblast, and then bends downward on the inner side of the latter, while the splanchnic mesothelium follows the deeper surface of the entoderm into the

same region. This last, however, has no concern for us at present.

From the angle just mentioned the somatic mesothelium now gradually extends upwards and inwards between the cells of the allantoidan trophoblast as a double sheet, dividing the trophoblast of this region into two layers. Finally, the mesothelium growing in from all sides meets and fuses above the embryo, which now lies in a cavity roofed in by an internal layer of ectoderm and an outer of mesothelium. Between this roof and the trophoblast there is now a space, lined on either wall by mesothelium, and hence clearly a part of the cœlom. The cavity above the embryo is the amniotic cavity, and its ectodermal lining is the amnion. It now shows in every relation exactly the same features as are well known in the chick; but, of course, these are derived in a greatly different way. We see from this that the first splitting in the ectoderm described above is the separation of amnion from the rest of the ectoderm. In the sauropsida and in some mammals, as is well known, the amnion arises in quite a different manner; not by the splitting of the ectoderm, but by the upgrowth and overgrowth of folds from all sides of the embryo—each fold consisting of ectoderm and somatic mesothelium—the folds at last meeting and fusing above the embryo, the final result closely simulating that described for the hedgehog. The question now arises, which of these two modes of amnion formation is the primitive and which the derived condition? Hubrecht's line of reasoning in settling this question is, in outline, as follows: The am-

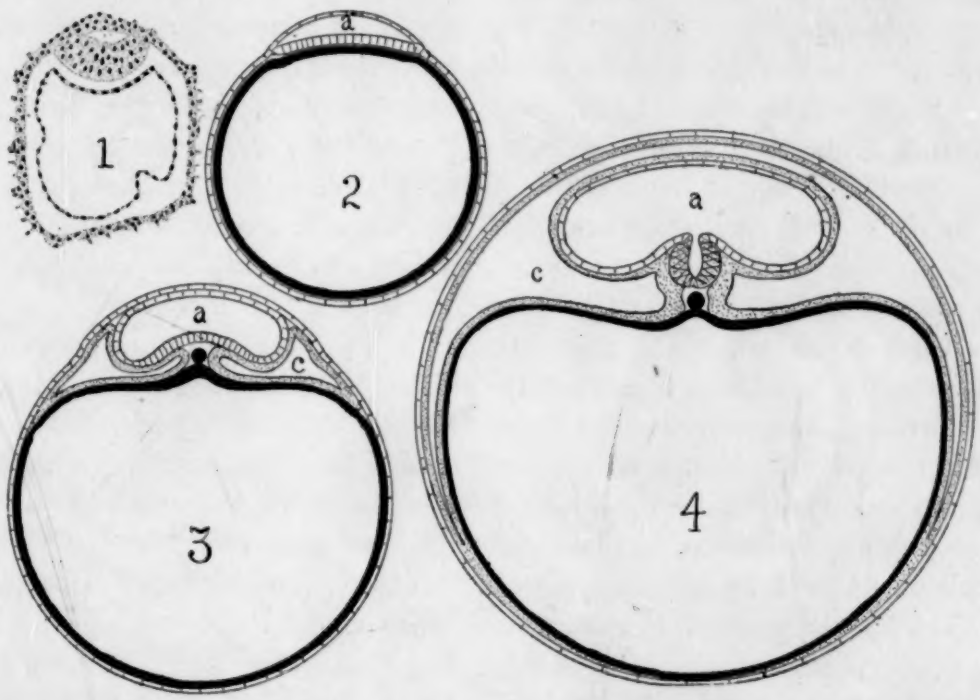

FIG. E. Diagrams of the Origin of the Amnion. 1. Section of an egg of *Erinaceus* after Hubrecht, showing the two layers and a cavity in the ectodermic thickening. 2, 3 and 4, diagrams of successive stages of formation of the amnion; ectoderm white; mesoderm dotted; entoderm black. *a*, Cavity of amnion; *c*, cœlom. 2. Diagram of the stage of Fig. 1, the amniotic cavity formed by splitting of the primitive ectodermic thickening. 3. Appearance of the mesoderm and cœlom, the somatic layer of the mesoderm growing upwards above the amniotic cavity, the roof of which is beginning to split into amnion and serosa. 4. Process of the amnion formation complete, the result closely similar to what is found in reptiles and birds.

nion, filled with fluid and surrounding the embryo, is clearly a protective apparatus. Its origin can in no way be explained by the presence of the large yolk or of an egg-shell, for in the sharks which have both no amnion appears. As a protective apparatus it, of course, would have the greatest value in an embryo developing inside the mother, protecting it, like a water cushion, from the peristaltic and other movements of the mother. Hence, it is more reasonable to look for the origin of the amnion in viviparous rather than in oviparous forms. Now, an amnion formed after the type found in the hedgehog can act as a protection from the very first, while one arising as in reptiles cannot have any protective value until the folds have completely closed over the embryo, and so it is difficult to account for the incipient stages in the reptilian type. Again, it is easy to derive the reptilian condition from that described, while the amnion of the hedgehog or of man is not easily explained on an hypothesis of descent from the reptilian condition. Hence it follows that there is no inherent improbability, and that there is much plausibility, in the view that the amnion formed by splitting is the primitive, that by overgrowth the derived type.

Now, where are there features that could have given rise to such structures? The ancestral form must have been viviparous, and it must have had a two-layered ectoderm. Now, the amphibia fulfill the conditions in both respects, for there are salamanders which bring forth living young, and nowhere in vertebrates, except in the amphibia, do we find a two-layered ectoderm, while here a two-layered condition occurs throughout the group; and further the outer layer does not participate in the formation of the embryo.

In conclusion, it may be said that at present the weight of evidence is in favor of an amphibian ancestry for the mammals, but when the known forms of amphibia are examined none is found which will meet exactly the requirements of the case. The limbless cæcilians are, of course, out of the line; the anura, with their reduced vertebral columns and reptilian ear structures, are equally out of the question. The urodeles approach more nearly to the ancestral form, but their skull is so degenerate that it cannot give rise to the zygomatic arch so characteristic of the mammals. There remains only the group of stegocephala. These are extinct forms, the earliest fossils of which appear in the Carboniferous, the subclass dying out in the Triassic. In every known feature these are closer to what the ancestors of the mammal must have been than are any of the other groups, and yet not a single form of stegocephalan is known which can be said to meet the demands required for the ancestor of the mammals. This ancestor must be some form closely allied to, but yet more primitive than, any known stegocephalan. Further, it may be said that we cannot derive urodeles, cæcilians or anura from any stegocephala as yet discovered.

The earliest known stegocephala are well differentiated and widely distributed, and they have a structure greatly different from that of the crossopterygian ganoids from which they have in all probability descended. The ancestor of the mammals partakes of characters intermediate between those of the crossopterygians and those of the most primitive stegocephalan known, and yet one in which the amphibian characters predominate over the ganoid features.

We must, however, remember that the geological record is as yet imperfectly known. We have as yet found no form which serves to bridge the gap between the finned and the limbed vertebrates. Footprints have been found in Devonian rocks in Pennsylvania which, in the light of our present

knowledge, we can interpret only as those of a stegocephalan, but no hard parts have been found to show us what the animal was like. We may hope, yes, almost expect, that future exploration will show us stegocephalans in rocks of Devonian age, and when those are found it is possible that they will embrace types which will be decisive as to mammalian ancestry. Yet how slight are the chances of such discovery is shown by one fact concerning our knowledge of the mesozoic mammals. Nearly half of the known species of these were found in a bed of clay in southern England, the whole deposit measuring forty feet in length, ten in breadth and five inches in thickness.

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*THE RELATION OF PHYSICAL GEOGRAPHY TO OTHER SCIENCE SUBJECTS.**

IN geography we have not as yet reached that stage when vague spheres of influence give place to definite territorial boundaries. Our science is still unorganized, its frontiers are not demarked and the dividing lines of its provinces are not yet drawn. My subject compels me to take up a number of questions still so unsettled that I can hardly hope to suggest even a *modus vivendi* which in this time of boundary disputes will be acceptable in all its details to many besides its author.

At least in America, we shall all agree that physical geography is not identical in its limits with what our English friends term physiography. It is not a summation of our knowledge of nature. Such was the older physical geography, and valuable as was its view over the entire kingdom of science, it was found impracticable as an educational instrument. With its string of disconnected chapters on the elements of physics, chemistry, astronomy, geology, botany, zoology, and ethnology, concluding perhaps with a chapter on precious stones, it is no wonder that there was sometimes applied to it the sacred definition of a circle whose center is everywhere and whose circumference is nowhere. And yet to many a boy it gave his only world-view, his only touch with nature. When Huxley spoke of it, this Erdkunde, as 'a peg on which the greatest quantity of useful and entertaining scientific information can be suspended,' it was not in disparagement; for he termed it one of the essentials of a liberal education.

Physical geography has often been treated as though it were equivalent to the 'science of geography,' as Strachey has defined it, or as synonymous with the 'general geography' of the Germans. But its note is neither the introduction of the causal notion nor a topical treatment of the subject. It is not to be set over against either descriptive or a real geography. Surely the adjective in the phrase may well have a restrictive influence. Either 'physical' as here used is equivalent to 'natural,' in which case our science reverts to physiography, or else it limits the subject to physical as distinct from biologic phenomena. Accepting this restriction, we may set the divisions of geography in the following scheme:

1. Chorographic geography.
2. Physical geography, with its subheads of the geography of the planet, the geography of the air, the geography of the sea, and the geography of the land.
3. Biotic geography, the distribution of animals and plants.
4. Anthropic geography, the geography of man.

The chorographic member, dealing with position, direction and dimension, is the rudiment from which the entire body of geography has developed. The map, its first product, remains its chief vehicle of

* Read before the Department of Science Instruction, National Educational Association, Detroit, July 12.

expression. I can only stop here to notice that in education this member has but recently passed its culmination. The leading American geography of twenty-five years ago, on account of its many excellencies called by Col. Francis Parker in 1894 'the best geography in English ever issued,' touched the highwater mark of topography. Its map questions on the continent of South America required a knowledge by the pupil of 9 capes, 48 cities and 30 rivers. The boy who knew his lesson in Guyot could tell you that the leading affluents of the Orinoco are the Venture, Coroni, Auraca, Meta, and Guaviari rivers. To-day the pupil in Frye escapes from South America with a burden of but 1 cape, 11 rivers and 25 cities, a total of 37 place-names of these three kinds, as against the 87 which his father learned in Guyot.

The space saved by this shrinkage is largely given in recent texts to the physical side of the subject. Our 'advanced' or 'complete' school geographies open with a compend of physical geography, and a wealth of physiographic material is scattered with free hand throughout the text. In the high-school our science is commonly reviewed as a distinct study.

In its opening chapter on the geography of the planet, physical geography borrows freely from astronomy. Its view-point, however, is geocentric. Its astronomy is planetary, not sidereal. No fact nor theory is introduced except in direct and important relations to the earth.

The geography of the air is practically conterminous from our standpoint with meteorology. It makes drafts on the elementary principles of physics. It everywhere introduces the causal notion. Both the physical and the purely geographical contents are indispensable, and it would be futile to attempt to isolate either.

Under whatever name meteorology is taught, it should have a large place in school programs, so many and so vital are our relations to this ocean of air at whose bottom we dwell, so fundamental are its effects on land forms, so immediate are its controls of the distribution of life. Few studies offer so good facilities for scientific observation. The apparatus it requires is inexpensive. The daily reading of its instruments, the search for the causes of to-day's weather changes and the effort to predict those of to-morrow, give training of high value. The school becomes in a way a member of a corps of scientific observers, since it receives each morning the records of the work of the Weather Service to compare with its own. Indeed, so valuable is meteorology as an educational instrument that it surely will win place as a distinct study in the high-school.

The geography of the sea is of minor importance to our subject, and we may pass at once to the pith of physical geography, the geography of the land, the science of land forms, or geomorphology, as it is technically and rather lengthily termed. It is here that our science presents the largest range and variety of phenomena. It is here that its relations to life are most direct and complex. So central is this portion of geography that all other divisions may be grouped about it in subordinate relations and the whole thus attain organization and unity. The geography of the planet, the sea and the air are prerequisite to the geography of the land, since it is by the action of the mobile envelopes that the forms of the lithosphere have been sculptured, while the applications of these physical conditions lead directly into the biotic and anthropic divisions.

It is not strange, therefore, that with the organization of the science the study of land forms has taken a large place. It is called by Penck 'the main part of geography proper.' The masterly treatise of de Lap-

parent 'Leçons de géographie physique,' is geomorphology pure and simple from beginning to end. Is this distinguished geologist of France biased by his profession? Well, here then is Boulangier, who in his 'Traité de géographie physique' reassures his readers that the author is *not* a geologist, and still defines his subject as 'the methodical and rational study of the surface forms of the planet.' Wagner excludes from our science both anthropic and biotic geography, while Supan admits, of the two, only the latter. Davis has given us under the name of physical geography the most complete and luminous treatise on land forms in the language, in which, however, there are everywhere introduced applications of physical conditions to the life of plant, animal and man—matter of great value usually omitted in European texts.

So rapidly, so lusty and so big has geomorphology grown that it has been suggested by Professor Dryer that it aims to play the part of the young cuckoo and oust from the nest the remainder of the geographical brood. It is scarcely of age, and yet the science of land forms has already rejuvenated geology and rationalized the domain of geography. Geomorphology is the child of geology and geography, and it inherits its father's strength and its mother's beauty. From geography it brings the 'half artistic' description of the features of the earth and their distribution; from geology it brings the reasoned processes of their formation. Just now it seems to be an educational question as to which of the parents the child should be given in keeping. Should land forms be taught in high-schools chiefly as physical geography or as geology? This is perhaps the most important question raised by my subject. It involves the relations of the two sciences and their educational values.

The overlap-land of geomorphology may be claimed by geology with as sure a right as any of its other provinces, such as paleontology. It was by geologists that it was explored. The Committee of Fifteen accredits the advance in scientific geography the last few decades to the work of geographical societies, and to a limited extent this is surely true, in Great Britain especially. And yet, as one of the foremost British geographers, H. R. Mill, has stated, it is 'the recent work of three geologists, Penck, Davis and Lapparent,' that 'has brought this aspect of the relation between geography and geology boldly to the front.' Without question it is by geologists that the science of land forms has been created. The list of the founders and leaders of the American school of physiographic geology, whose primacy is so generally admitted, is quite too long for mention, but I cannot omit the names of Powell, Lesley, Gilbert, Davis, Dutton, McGee, Chamberlin, Russell and Tarr. How large, also, have been the contributions of foreign geologists, such as Ramsey and Geikie, Richthofen, Suess, Heim and Walther, Noe, Margerie and Lapparent. If some of these, as Penck and Davis—to the latter of whom Lapparent justly attributes 'the preponderating influence in the development of the new conceptions'—are officially known as professors of physical geography, they belong, notwithstanding, to the brotherhood of the hammer.

The attention of geology was early diverted from the study of land forms, but it brings on its return a wealth of material which compensates amply for its absence. The reports of the U. S. Geological Survey contain a body of physiographic information and doctrine unequaled in the publications of any scientific society. Our recent State surveys show the splendid results of the application of the methods of the geologist to the study of reliefs, as in the work of Salisbury in New Jersey, Calvin in Iowa, and Marbut in Missouri. The new geology describes the forms of the land with a pre-

cision and detail hitherto unknown. It refers them to their places in a genetic classification. It assigns them to their order in an evolutionary life history. Furthermore, it uses them as the older geology used fossils and the succession of strata; it reads in reliefs the story of the geological past. It not only explains the present by the past, but it also reveals the past by means of the present. The physiognomy of a region may be the record of a large part of its geological history. While the geomorphologist requires the special equipment and competence of the geologist, it is no less true that the geologist must now perforce be a geomorphologist.

In the geological courses now offered in American universities land forms have a large and increasing place. It is given under different names, but with essentially the same content. In some, as in the University of Wisconsin, applications to human life are included, an essentially geographic subject. In the higher American schools, with one notable exception, Harvard, it is only in the laboratories and lecture rooms of the department of geology that the student of land forms can obtain adequate training. "The surest foundation," as Richthofen has said, "for the study of geography is geology, in its whole compass, as being the only means to an understanding of the earth's surface." Geology thus retains possession of the field both in research and in advanced instruction.

As Davis has pointed out, land forms are functions of three variables—structure, process and time. The first of these, structure, together with the causes which have produced it, is undoubtedly a geological subject, and it is from geology that the geomorphologist must here draw all his data. Process has always been treated under dynamic geology, and yet as a part of geophysics, as treating of agents now in action upon the earth, it belongs also to geography. The cycle of time, 'that unmeasured part of eternity,' during which process produces upon structure the evolving series of topographic forms may well be claimed by the science which deals with the past history of the earth. The position of geologists is well stated by Sir Archibald Geikie in answer to the argument of Sir Clements Markham, President of the Royal Geographic Society, who had drawn the line between the two sciences at the dawn of history, excluding geology from the study of the changes of the earth's surface since that time. "Since geology may be regarded as the history of the earth, whatever is necessary for the elucidation of that history will be claimed by the geologists as part of their domain. Only as they understand what is going on at the present day can they understand what took place in past time. If you take away from the geologist the study of all that is taking place now, and maintain that this study is not geology but physical geography, he will answer, 'I do not care what you call it. I must be at liberty to investigate the processes which are operating now, in order that I may be able to explain what has happened in past time.'"

The dependence of geography on geology often has been compared with that of painting or sculpture upon anatomy. But the simile is far from complete, unless the former science is content to remain descriptive only, dealing with the delineation of external form. For the reliefs of the land must be studied and classified not primarily or chiefly as to form, but by structure and genesis. So soon as the description of the features of the earth's surface and their distribution yields to an inquiry into their origin, the line is passed which divides the -graphy from the -logy.

These questions are not perhaps without some practical outcome. The organization of these sciences, and the theoretic limits between them in the field of research in-

fluence our high-school courses sooner or later. It is in this somewhat remote field that the deciding factor may be found which shall at last settle the matter as to whether the physiognomy of the land be chiefly taught in secondary schools as geology or as geography.

Fortunately certain criticisms of each science have been laid by recent educational progress. In view of our present text-books, physical geography can no longer be called 'hash' nor can geology now be termed dry and dull. Neither of these earth sciences is dull except to the dullard. So large is the place of land forms in both the new physical geography and the new geology, that it is now a question of approach to a common content of knowledge.

Let me claim for geology the easier path of approach, the clearer and more natural method of presentation, the greater coherence and the vaster and more inspiring view.

The geological path is that of process. It studies the agents now in operation with the resulting structures and forms that are produced at each stage of the evolutionary cycle. It thus binds together cause and effect as closely as possible. It admits an inductive treatment based on the observation of common things. The geographical path is normally that of form. In many of our physical geographies this has been avoided and the geological approach frankly taken in its stead, this portion of the subject becoming an epitome of dynamic geology. It is perhaps owing to the personal equation that to me the method of classification by form seems somewhat miscellaneous and scrappy. It throws together, for example, phenomena as diverse genetically as the glacial plains of Iowa, the base plains of Russia, the lava fields of Oregon, the old lake floor of the Red River of the North, and the coastal plains of the Gulf. Supan is compelled by his method of arrangement to take up the glacier under three of the five great divisions of his Physical Geography—under the atmosphere where the general description is given, under the Dynamics and under the Morphology of the Lands. There is no question of the value of such a classification to the advanced student. Is it as good for the high-school pupil as that of geology, which, in the case of the glacier, for example, draws from meteorology the climatic conditions, and from geography the description of its features, and then proceeds forthwith to treat of its work as a geological agent and of the land forms thus produced? It is perhaps because of the easier path and better method which geology offers that in the courses at Cornell University, N. Y., a year in it precedes the year offered in physical geography.

Geology also gives what a painter would term atmosphere to this common body of knowledge. It sets it in perspective. To an extent this is also done by physical geography, and I confess that I have been surprised to see how readily students of recent texts, such as Davis's, gain a realization of the time-element in the geographical cycle, though they have had no geological preparation. But these conceptions are enlarged and vivified by the detailed study of geologic time. It is well to know the geography of the Allegheny mountains, it is better still to know their morphogeny, but it is best of all to set the whole in geological perspective, to view their folding in the remote close of the Palæozoic, and their long waste during the Middle Age of geology to a plain whose gradual dissection after uplift and during subsequent cycles has sculptured these mountains to the forms we behold to-day.

It is also something to set to the credit of geology that it teaches the history of organic evolution. Perhaps we have not as yet learned to paint the panorama of creation so that its salient features are not

smothered in detail. But to know what the earth is we must know what the earth has been. The story of the planet and the life it has sustained is prerequisite to a complete understanding of the earth sciences and of the life sciences as well.

As an educational instrument geology has the advantage of concentration and homogeneity. If, like mathematics or physics, it lacks the warm human interest, the applications of geography to human life, yet its current is not shoaled by division into numerous channels. If either physical geography or geology must be omitted from our crowded high-school courses, let it not be geology, the more fundamental, the more coherent, the more educative of the two.

What then should be the place and sequence of the earth sciences in secondary programs? Can they be arranged so as to include the outlines of all, and yet without repetition? It seems to me that certain changes are desirable to secure this end. I should like to see nature study so enlarged in the lower grades that the common physiographic processes early become familiar. There is an evident trend toward the enlargement of the physical geography with which our advanced geographies are now introduced. To me this seems the proper place for the study, but while the treatment of all essential forms and processes which bear directly on the life and work of man may be expanded, all matter irrelevant to this should here be omitted. I should like to see the areal and descriptive geography which follows so enlarged that it will take in the American high-school the place it holds in the German *Realschulen* and *Gymnasia*. Each geographic unit, each region of our country, each national domain may then be treated thoroughly in all departments of the science. With the physical environment everywhere made basal, we need not fear to give anthropic geography the largest possible place. It may be that much might be brought in which a strict definition of geography would exclude. But with due selection of material, with grasp of principles, with historic perspective, and especially with a thorough knowledge of physiographic controls, the wise teacher of geography can afford to take as his motto, I consider nothing alien to myself that relates to man. The extension of anthropic geography, however, cannot be brought about by discussion, or criticism, or the writing of text-books. It must come in precisely the same way as has the extension of physical geography—by scientific research. It awaits the masters who will some time do for the sciences relating to man what geology is doing for the science of land forms.

The proper place, then, for physical geography is a place preliminary to the areal geography which applies its principles and consequences to special regions. To review it later as a separate study would then seem unnecessary. Instead, let the course in the earth sciences be concluded by meteorology and geology. The earth sciences may thus be so closely articulated as to form the vertebral column of secondary scientific instruction. So close is their touch with human life, so thorough and comprehensive is their discipline, so simple, so natural, so rational, and so real is their culture, that their extension only awaits their connection into one continuous line of study.

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Professor Fraas on the Aqueous vs. Æolian Deposition of the White River Oligocene of S. Dakota.

A special expedition of the United States Geological Survey into the Bad Lands of South Dakota was led by N. H. Darton, of the Survey, assisted by J. B.

Hatcher, of the Carnegie Museum; with the party was also Professor Eberhard Fraas, of Stuttgart. The object of the expedition was to secure exact geological data for the monograph 'The Titanotheres,' now in preparation by Professor Osborn. The matters of chief importance were: first, to determine the mode of deposition of these beds in view of the arguments recently brought forward by Matthew, Davis and others that they were æolian rather than aqueous in origin; second, to determine the exact stratigraphical levels upon which the different types of skulls and skeletons have been found, verifying and extending the very careful records made by Mr. Hatcher between 1886 and 1888 while collecting for the United States Geological Survey, under Professor Marsh.

Mr. Darton will prepare the formal report of the geological results of this expedition, including a map showing the extent and exact thickness of the beds in different portions of this region. In the meantime it is interesting to learn the opinions of a highly trained European geologist, Professor Fraas, upon the nature of these beds, expressed in an informal letter to Professor Osborn:

"I take this opportunity to briefly present my opinion on the origin of the Oligocene of the Bad Lands. So far as I have been able to observe the beds during the past eight days, one can by no means speak of their structure as æolian in the ordinary sense of the word. It is quite possible that wind-transport may have taken some part in their formation, but the strata themselves appear to me to have been chiefly laid down under water. We ought, I think, to take into consideration the following series of different petrographical and structural conditions:

"(1) The *Titanotherium Beds*, which constitute the base of the Oligocene, I take to be the deposit of a slowly flowing river, which emptied in the broad delta upon the level stretches of the Ft. Pierre [Middle Cretaceous]. This view is supported by the occurrence of large boulders of ground-conglomerate at the base of the *Titanotherium Beds*, as well as by the frequent embedding of sand and gravel in the clays and marls. The current was manifestly very gentle and laid down a continuous substratum, resulting in cross-bedding in the sands and gravels. Against the dune-structure (æolian) testify the widespread layers of sand banks, often very thin, the heavy gravel and the fine lamination of the clays. The current was directed from west to east, and corresponding to this the thickness of the gravel and sand layers diminishes as we pass eastwards. (2) It is very difficult to determine the origin of the overlying *Oredon Beds* [Middle Oligocene, 560 feet in thickness]. We must take the following facts into consideration: (*a*) The entire material has undergone a strong metamorphosis; the sandy, non-calcareous clays were formerly marls rich in calcareous matter, the concretionary structure of the harder banks and the texture of the material giving positive evidence on this point. (*b*) Certain layers were very rich in gypsum and barite; both minerals are now represented only in pseudomorphs of chalcedony, formed out of gypsum and barite. Probably there was united with the tendency to gypsum formation, a similar tendency to rock-salt formation, but I have found no evidence of this. (*c*) The structure of the layers: In the *Lower Oreodon Beds* concretions are abundant, which originally were composed of clays rich in calcareous matter. (This is the principal layer of *Testudo* and of the mammals.) Here are also thin banks of clear limestone, now strongly silicified; land and fresh water snails are found here (*Helix* and *Limnæa*); sand layers are not found here. The very massive *Middle Oreodon Beds* are splendidly laminated and

horizontally banded; that is, the colors change regularly from clear to dark. At times, in the darker portions are observed harder layers of limestone rich in clay. In the lowest layers of these middle beds we find the greatest abundance of gypsum and pseudomorphs. A layer of compressed smooth lenses of sandstone frequently appears (*Metamynodon* and *Protoceras* sandstone). Where the lenses are thin and smooth the lamination is even, where the layers are thicker, with coarser material, we observe cross-bedding. The *Uppermost Beds* of the White River Oligocene are altogether different. They are composed of very uniform material (often of volcanic ashes according to Dr. Darton), containing numerous nodules and round concretions; there are also large concretions, with the turtles again abundant, in fact, arranged quite differently from the Lower and Middle Beds. This sedimentation is manifestly of æolian character.

"When we put together all these observations to form a conclusion as to the structure of these beds we come to the following result: At the beginning [of the Oligocene] a broad, slowly flowing stream spread out towards the east and formed a broad, widespread and uniform delta landscape (Titanotherium Beds); this even, swampy land was dry during the dry seasons, but was flooded in every high-water period; besides the water the wind frequently took part in the transport of the dust and materials. The concretions are structures of the percolating waters (Lower Oreodon Beds, numerous land mammals). Now followed a long period in which this region was flooded by a shallow rather than deep lake. The inflow of water did not exceed the evaporation, and so through the varying concentration there was a precipitation of the dissolved materials which gave rise to the banded layers. In the same manner the gypsum and barite in these layers is explained. Stronger currents poured in sand, which accumulated in low elevations (Middle Oreodon Beds). At last there came a widespread æolian condition in the form of loess, which spread out upon the gradually retreating or evaporated levels of the lake."

CHARLES ANTHONY SCHOTT.

With the death of Charles Anthony Schott, Assistant, United States Coast and Geodetic Survey, closes a most useful life, led by a remarkable man.

He was born at Mannheim, Baden, Germany, August 7, 1826, and began his studies very early, learning to read before reaching four years of age, and it is stated that his work began as a small boy. He graduated from the Polytechnic School at Carlsruhe with the degree of C.E. in 1847.

He came to the United States in 1848 and entered the United States Coast Survey, thus beginning his life of enthusiastic work in the advancement of science by the solution of the problems which confronted this organization created to obtain accurate charts of the extension coasts of the United States. He was immediately attached to the Computing Division in the office of the Survey where he remained until October, 1849, when he was assigned to the schooner *J. Y. Mason* and steamer *Walker* as hydrographic draftsman. In July, 1850, he returned to the Computing Division and on July 1, 1852, he was regularly appointed to the position of computer. From time to time he acted as chief of the Computing Division in the absence of the regular Chief and in 1855 was permanently placed in charge of this most important Division. In 1856 he was advanced to the grade of assistant, the highest in the survey after the superintendent.

The ability, zeal, indefatigable industry and vast mental resource so eminently

shown throughout his career, was thus recognized by Superintendent A. D. Bache at an early day. This assignment was most fortunate for the interest of science in general and particularly so for the advancement of the work undertaken by the Survey. In the Computing Division the fundamental data obtained in the field is digested and discussed for publication and this data, after passing through the Division, furnishes the foundation upon which the work of the Survey is built up. A wonderful opportunity was thus offered to a man capable of distinguishing himself, and this opportunity was seized by Mr. Schott and utilized to the fullest extent. The results of his painstaking labor are shown in the numerous publications bearing his name in the annual reports of the Superintendent and in scientific journals.

Mr. Schott's regular duties in the office were interrupted from time to time by assignments to special duty in the field. As early as 1855 the records show that he was in charge of the magnetic work of the survey and in 1863, during the time of the national peril, he was engaged in surveying the defences of Washington. In 1869 he took a party to Illinois to observe the total eclipse of the sun and in 1870 went to Catania, Sicily, as a member of the Superintendent's party to observe an eclipse of the sun. At various times during the absence of the assistant in charge of the Survey Office, he acted in his place.

Mr. Schott continued in charge of the Computing Division until December 31, 1899, and on January 1, 1900, was relieved of this duty and assigned to the discussion of the arc measurements in the United States resulting from the extension triangulation already executed by the different organizations engaged in survey work. All the available triangulation of a sufficient degree of accuracy is utilized in these discussions. 'The Transcontinental Triangulation and American Arc of the Parallel,' has already appeared as Coast and Geodetic Survey Special Publications No. 4, and 'The Eastern Oblique Arc of the United States' is now ready for the printer. The discussion of an oblique arc in California was far advanced before Mr. Schott's health failed and will bear the mark of his genius when it finally appears in print.

It is impracticable to give a *résumé* of Mr. Schott's work in the survey at this time and reference can only be made to the 'Annual Reports' of the survey covering the years of his services for the innumerable results of his labor.

The following extract from SCIENCE of January 12, 1900, is a fitting tribute to Mr. Schott's work as Chief of the Computing Division.

> With the close of the year, assistant Charles A. Schott, who for nearly fifty years has been the distinguished and energetic chief of the Computing Division of the Coast and Geodetic Survey, retired from that important position in order to devote his whole time to special scientific work.
>
> Under Mr. Schott's careful supervision and training has developed a corps of skilled computers equalled by no other scientific bureau. To his labors, perhaps more than to any other one man's, is due the high scientific character of the results which the Survey has given to the world. The completion last year of the great arc, begun over a quarter of a century ago, marks an epoch in the history of the Division, and the beginning of the triangulation on the 98th meridian would seem to be a fitting occasion for relieving Mr. Schott of the burden he has borne for so many years.
>
> His official career has been coincident with the development of the Survey, and his untiring zeal and fidelity have done much to bring about its present standard.

In 1898 Mr. Schott attended the 'International Conference on Terrestrial Magnetism' held in Bristol, England, as the representative of the United States Coast and Geodetic Survey.

He took part in the discussion, and his proposal that a permanent magnetic observatory should be maintained for a series of

years in the Hawaiian Islands was received with acclamation.

Later in the year the French Academy of Sciences awarded him the Wilde Prize on account of his researches and publications in the field of terrestrial magnetism. This prize was founded by Henry Wilde, an English scientist who gave the French Academy of Sciences a sum of money, the income from which forms a prize described as follows, in the *Comptes Rendus Académie des Sciences*, France, No. 126, p. 144: "This prize will be awarded each year, beginning with 1898, by the Academy of Sciences, without regard to nationality, to the person whose discoveries or publications under astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics, shall be judged by the Academy most worthy of reward, whether that discovery or publication was made in the same year or in some other year before or after the foundation of the prize."

In accordance with the deed of gift this prize was awarded for the first time in 1898, and Mr. Schott received it in due form through the Department of State and from the hands of the President. The following extracts are of interest from their bearing on this memorable incident:

Extract from *Comptes Rendus Académie des Sciences*, France, No. 127, p. 1097.

The Henry Wilde Prize.

Committee M. M. Sarrau, J. Bertrand, Berthelot, Michel Lévy; Mascart, Secretary.

At the session of July 12, 1897, M. H. Wilde presented to the Academy of Sciences, under the name of Magnetarium, a remarkable apparatus now in the Museum of Arts and Industries which permits of the reproduction on the surface of a sphere, with marvelous accuracy, the distribution of the elements of terrestrial magnetism and their secular variations.

The Commission has decided that, in order to render homage to the inventor of that great work, it is desirable to make the first award of the prize founded by M. Henri Wilde to researches relating to terrestrial magnetism.

Since 1869, the 'Annual Reports' of the United States Coast and Geodetic Survey contain, almost every year, memoirs of the greatest interest by Mr. Charles A. Schott, on the determination of the magnetic elements at the permanent observatories of the United States, and at a great number of temporary stations. The extensive work accomplished by Mr. Schott can not be stated in a brief *résumé*. * * * One finds in his memoirs an explanation of the methods employed in the observatories and in the course of journeys; a comprehensive view of the results obtained since the first observations on the American continent and a certain number of foreign stations; an exhaustive discussion of the readings made of the apparent variations in certain observatories with the study of the diurnal change for the different months of the year, of the lunar influence and perturbations; and lastly a considerable number of personal observations in many isolated stations; this work permits the establishment of the lines of magnetic distribution in North America. The whole of this work furnishes one of the most important contributions in the history of terrestrial magnetism and the Commission is unanimous in awarding the Henry Wilde prize to Mr. Charles A. Schott.

From the *Public Press*, February 4, 1899.

"An interesting episode took place at the White House this afternoon at 4 o'clock, when, in the presence of the Secretary of the Treasury, the Superintendent of the Coast and Geodetic Survey, and twenty-five of Mr. Schott's colleagues, the President presented to Mr. Charles A. Schott the prize recently conferred upon him by the Academy of France. This prize of 4,000 francs was founded by an Englishman about two years ago, and was to be conferred by the Academy on any person, in any country, whose discoveries in science, or whose original investigations had been most valuable and had contributed most to human knowledge, in the direction of mathematics, mechanics, physics, chemistry or geology. The Academy, after due consideration, conferred the prize on Mr. Schott for his investigations into the laws of terrestrial magnetism.

"After the officers of the survey had been duly introduced to the President and to the Secretary, by the Superintendent of the Coast and Geodetic Survey, the official papers containing the award were placed by

the President in Mr. Schott's hands, and in doing so he alluded in the following words to the international character of the prize, and to the catholicity of scientific work:

"I have great pleasure in placing in your hands the formal papers which convey to you the 'Wilde Prize.' This prize, founded by an Englishman who has a deep interest in science, has been adjudged to you by a committee of eminent men chosen from the most famous organized body of scientists in the world—the Institute of France. According to the terms accepted by the Institute of France in founding the prize, it was to be given to the person from any nation whose discoveries in physics or mathematics, mechanics, chemistry or geology are most valuable, or whose original researches in these branches of science have been most successful. The prize has been awarded to you for researches in the important field of terrestrial magnetism.

"I congratulate you and American science, and in particular the Coast and Geodetic Survey (the scientific organization of which you are a member), that you have been chosen from all the world as the most worthy to receive this great honor.

"It is especially pleasant in this age when international relations are of high importance, when the methods of modern applied science have brought all nations, however geographically remote, into close contact, to know that in science there are no international boundaries; and no pleasanter proof of this catholic spirit could well be given than this fine prize —one of the highest that can be conferred by a scientific body—founded by an Englishman, has been awarded by a Frenchman and won by an American."

Mr. Schott's ability and attainments have been widely recognized by learned bodies and scientific societies as shown by his election to membership on the following dates:

1871. Philosophical Society of Washington, D. C. (Founder).

1872. National Academy of Sciences.

1874. American Association for Advancement of Science (Fellow).

1896. Sociedad Cientifico Antonio Alzate, Mexico.

1898. Washington Academy of Sciences (Founder). Accademia Giocenia di Scienze Naturali, in Catania, Sicily.

The long list of publications bearing Mr. Schott's name bear testimony to his untiring industry and his devotion to the interest of the service, which he honored as a member and to the advancement of human knowledge. ISAAC WINSTON.

GEORGE K. LAWTON.

IN the unexpected death of George K. Lawton, of the U. S. Naval Observatory, a young astronomer of great promise has passed away. The loss to American astronomy can be appreciated as yet only by those who had the good fortune to know him intimately. He was born October 20, 1873, and died at Washington, July 25, 1901, after a brief illness of twelve days, of typhoid fever; and was thus less than twenty-eight years of age. Under the guidance of his father, Professor U. W. Lawton, of Jackson, Michigan, he had enjoyed from childhood excellent educational advantages, and in 1895 graduated in classics at the University of Michigan, where he also pursued advanced astronomical studies under Professor Asaph Hall, Jr., at the Detroit Observatory. He then spent a year in post-graduate study at the University of Chicago, where the writer had the honor to be one of his teachers. He showed distinguished abilities in the study of celestial mechanics and of higher mathematics. He was afterwards attached to the Observatory of Yale University for a short time, occupied mainly with work on meteors; and then came to the Naval Observatory as one of the regular computers. In 1897 he took the degree of M.A. at the University of Michigan. While attached to this Observatory he participated in all the transit circle observations of the past five years, much of which has recently appeared in the *Publications of the U. S. Naval Observatory*, Vol. I., new series. Last year he bore an important part in the observations of the total eclipse of the sun, at Pinehurst, North Carolina. More recently he took a leading part in the reductions and revision of the Eros observations of this Ob-

servatory, and has been occupied partly with equatorial work. Only a month ago he was assigned to the 26-inch equatorial, and had entered upon researches of great promise.

On account of his extreme modesty, and the arrearages of our publications, his scientific reputation at the time of his death was in no way commensurate with his merits. Yet he was already a member of the American Association for the Advancement of Science, and last year participated in the meeting of the Astronomical and Astrophysical Society of America.

His mind was developed in admirable symmetry and harmony, and his scholarship was almost as good in Latin and Greek and general literature as in modern science. He had that happy faculty of cool, quiet judgment, combined with good nature, which made him adequate to any occasion. Besides possessing scientific and literary talents of a high order, he was of a very high-minded and noble disposition, universally beloved by his associates. Unseen by men he continually did many acts of benevolence, and bestowed gracious remembrances which add to the charm of life and make us realize that the high types written of long ago have not wholly passed away. He was an active member of St. Thomas's Church in this city and of the Brotherhood of St. Andrew and of the Alumni Association of the University of Michigan. During his residence here of five years, he became fairly well known in the city, more by the reputation of his high character than by any very extensive mingling with the people. When the writer had to send the saddest of messages to his grief-stricken family, the telegraph operator who knew him only by reputation was nearly overcome, and said,' That good man is not long for this world.' In all my experience I have never met quite so modest, so noble, and so lovely a character.

The sudden death of Mr. Lawton, almost at the very beginning of what promised to be a brilliant career, has cast a deep gloom over the entire Observatory. He was indeed the noblest of the noble, and his place can never be filled.

T. J. J. See.

Washington, D. C.,
July 27, 1901.

SCIENTIFIC BOOKS.

Astronomischer Jahresbericht. Mit Unterstützung der Astronomischen Gesellschaft herausgegeben von Walter F. Wislicenus. II. Band, enthaltend die Litteratur des Jahres 1900. Berlin, Georg Reimer. 8vo. Pp. xxv + 631. Price, M. 19.

This series of annual volumes, whose somewhat cumbrous title is officially abbreviated to the symbol AJB, owes its inception to its editor, Professor Wislicenus, who in September, 1898, submitted to the Astronomische Gesellschaft a well-elaborated plan for a yearbook that should serve both as an annual summary of current astronomical literature and as a bibliography sufficiently complete for the use of students and other investigators. The proposal was favorably received by the Society, which not only gave its official sanction and pecuniary support to the undertaking, but also appointed a committee, consisting of Professors Seeliger, Bruns and Müller, to confer with the editor as to the contents of the future volumes and the manner of their arrangement.

The plans thus agreed upon and incorporated in the first volume, that for 1899, have been closely followed in principle in the present volume, although with greater completeness of detail, as is shown by the addition of nearly a hundred pages to its size. That so few modifications should be found necessary in the second year of publication is sufficient indication that future volumes may be expected to appear in substantially the same form and character as the two already issued.

Premising that in its entire scope the AJB is to be purely expository and not critical in its summaries, the editor indicates it to be his purpose to treat with all possible completeness the purely scientific and technical literature of

theoretical and practical astronomy and astrophysics, together with, in smaller measure, that of the higher geodesy. Mathematical and physical papers are to be included in the scope of the work only in so far as they have a direct bearing upon one or more of the topics above named, while the literature of meteorology and geophysics is wholly set aside as foreign matter. With regard to the popular literature of astronomy the editor sagely remarks that while for the most part it is of small scientific value, the bibliographic purposes to be served by the AJB call for a fairly complete summary of this literature, including even 'crank' papers, all of which are to be presented in a purely objective manner without comment or criticism, in order that 'the reader may be given an opportunity to form for himself a provisional judgment of the article abstracted.'

In respect of arrangement the subject matter of the AJB is divided into four principal categories, entitled: General and Historical; Astronomy; Astrophysics; Geodesy and Nautical Astronomy. These are appropriately subdivided, while a brief supplement, of only four pages, contains the miscellaneous matter that the editor has not found expedient to classify under any of the preceding titles. Noteworthy in this connection is the following criterion by which papers upon astronomy and astrophysics are assigned to their respective classes: Problems involving only space and time relations of the celestial bodies constitute astronomy; problems of the celestial bodies involving other elements than the above are to be classified under astrophysics. As the editor himself notes, this rule of classification assigns to astrophysics the visual estimation of stellar magnitudes even though made in connection with meridian circle work, while the spectroscopic determination of motions in the line of sight is assigned to astronomy. This reversal of the popular classification seems to the reviewer sound in principle and well adapted to become the general practice.

Some conception of the amount of labor involved in the preparation of the abstracts here presented may be formed from the list of nearly 200 periodical publications, including publications of observatories, which have been so largely drawn upon for abstracts that the editor has found it convenient to assign to their names abbreviations for permanent use. To this material there must be added books independently published and periodicals rarely cited. As a type of the latter and a source not usually included under astronomical literature we note *The Congressional Record* and several of the monthly magazines commonly sold at news-stands and on railway trains. The bulk of material to be digested is beyond the competence of any one man, and the editor has therefore associated with himself seven foreign colleagues who are charged with the supervision of special portions of the work, in large part pertaining to the literature of their own countries. The American representative is Dr. H. S. Davis, who has elsewhere requested that papers of American origin which are germane to purposes of the AJB and are published in such manner as not to be readily accessible through the ordinary channels may be sent to him for review at the address, International Latitude Station, Gaithersburg, Md.

In respect of scope and plan the AJB is beyond question a welcome addition to the literature of astronomy, but one whose actual value must be tested by the experience of many persons in using it as a work of reference. A subject index is hardly to be expected in a volume of this character and no attempt at furnishing one is made, but the well-classified Table of Contents and an extended Index of Names, including institutions as well as persons, will be found of service by whoever uses the volume for serious purposes. A feature of special value to computers of orbits is the tabular Index of Observations of Comets and Minor Planets occupying no less than 34 pages of the volume, which cannot fail to save much time that has hitherto been spent in the endeavor to make complete the computer's list of observations of the object with which he is concerned.

So far as may be judged from its apparatus of classification, cross references, indexes, etc., there is no reason apparent to the reviewer why the AJB should not stand the test of time and use, and in those parts of its subject matter with which the writer is specially conversant he has found the work eminently complete,

satisfactory, and convenient to use. It is certainly worthy of a cordial reception by all who are interested in the progress of astronomy, and the editor should receive that cooperation which he solicits for future volumes by bringing to his notice all published articles which come properly within the scope of the work.

George C. Comstock.

Les plantes tinctoriales et leurs principes colorants. By V. Thomas (Chef des travaux de chimie appliquée à la Faculté des Sciences de Paris). Une publication de l'Encyclopédie Scientifique des Aide-Mémoire. Publiée par Gauthier-Villars, Paris, sous la direction de M. Léauté (Membre de l'Institut). Pp. 196.

The author divides the study of tinctorial plants as follows:

1. The coloring matters themselves.

2. The glucosides; the form of combination in which coloring matters exist most frequently in plants.

3. The ferments capable of decomposing these glucosides into sugars and the coloring matter.

4. The tinctorial plants themselves, from the point of view of the coloring principles which they contain.

In a previous volume in this same series, 'Matières colorantes naturelles,' the author has already discussed those natural coloring principles which belong to the keton, xanthon, and pheno-γ-pyron groups.

Part I. (pp. 7–142), therefore, of the present volume, treats of the remaining important plant-coloring principles, arranged in the following chapters:

Chapter 1. Colors of the anthraquinon group; alizarin, xanthopurpurin, munjistin, rubiadin, chrysazin and chrysammic acid, purpurin, pseudopurpurin, alkannin, morindon and ventilagin.

Chapter 2. Brasilin and brasilein; including isobrasilein, and derivatives of brasilin and dehydrobrasilin, together with a review of the work done by Perkin, Kostanecki, Herzig and others, to establish the constitutional formula of brasilin.

Chapter 3. Hæmatoxylin and hæmatein; also isohæmatein and derivatives of dehydrohæmatoxylin.

Chapter 4. Miscellaneous coloring matters, as follows: cyanomaclurin, genistein, gossypetin, rottlerin, flemingin, orcein, santalin, carthamin, lokanic acid, crocetin, curcurmin, lapachol, lomatiol, and bixin.

A brief history of every color is given, then the most interesting and important methods for obtaining it, together with its most characteristic physical and chemical properties and a discussion of its structural formula. The tinctorial properties are dealt with briefly, tables being freely employed to show change of color with change of mordant, effect of various substituting groups upon the color, comparison of shades obtained from the natural colors with those obtained from the same colors prepared synthetically, etc.

Part II. (pp. 143–180), Glucosides. Includes the consideration of the following: ruberythic acid, glucosides of quercetin and its derivatives, apiin, vitexin, morindin, datiscin, crocin, fustin, lokaonic acid.

Then follows a list of the principal tinctorial plants, arranged alphabetically according to their botanical names, and showing the coloring matters which they contain; also an alphabetical table of the coloring principles themselves, giving their melting points and the references to the text where the same are described in detail.

The references to the literature form a commendable feature of the work, thus affording ready access to the original articles.

Upon the whole, the book gives a very good digest of the work in this field and should prove of value to the chemist.

Marston Taylor Bogert.

Mosquitoes: How they live; how they carry disease; how they are classified; how they may be destroyed. By L. O. Howard, Ph.D. New York, McClure, Phillips & Co. 1901.

One of the triumphs of the combined labors of modern biologists and students of medicine is the discovery of the animal parasite of malaria and of the fact that the parasite of yellow fever, whether it be an animal or a bacterium, is, like the malarial one, transmitted by the mosquito.

Already has the number of workers become numerous, and the literature extensive, while the probability that man will be able to cope with these two dreadful scourges of his race, and at least greatly curtail their ravages is very great. We need, then, the fullest knowledge of the structure, habits and transformation of mosquitoes, particularly of the genus *Anopheles*, the bearer and transmitter of these diseases, and of the nature and life-history of the parasitic organisms which cause these diseases.

As regards the mosquito Dr. Howard has given us a capital book. It is both popular and entertaining, and yet truly careful and scientific in its scope and treatment. The physician cannot do without it. As for the entomologist, we venture to say that nowhere will he find a more fresh and up-to-date account of the mosquito. He will look elsewhere in vain for the many details which have recently been discovered by Dr. Howard and other American and European observers.

The figures of the different forms, particularly of the malaria-bearer, *Anopheles*, are new and very carefully drawn; the larval and pupal forms are rendered with great apparent accuracy. Of the greatest interest is the new matter relating to the subject of parthenogenesis among mosquitoes, the food and mode of getting it by the mosquito larvæ, and the food of the adult. The latter subject is treated with a fulness of new details which is most satisfactory. It is some comfort to learn that mankind does not form the sole pasturage of the female mosquitoes, but that they will sting terrapins and puncture the head of young fish, besides sucking the blood of birds. We had previously only known of Dr. Hagen's observation of a mosquito feeding on the chrysalis of a butterfly. We also are told that mosquitoes are plant-feeders, apparently piercing the flowers of the wild cherry, and feeding readily on fruit, especially bananas; and that the male mosquito is exclusively vegetarian in its diet.

The life-history and œcology of the malarial mosquito, *Anopheles*, is very well done. First we have a full and well-illustrated account of the common *Culex pungens*, with which may be compared, thanks to the abundant and well-drawn figures, the life-history and structure of the pestiferous *Anopheles*. The egg, the larva of different ages, with anatomical details, the pupa, as well as the fly, male and female, are represented, and there is added an account of the North American species. The food of the larva seems to be the spores of algæ, and in Sierra Leone a unicellular protococcus. How *Anopheles* bites and its length of life are also described.

The chapter on mosquitoes and yellow fever; mosquitoes and filiariasis; the account of the mosquito (*Stegemyia fasciata*) which conveys the infection, with figures of the winged insect, its scales, larva and pupa, are of much value. It is refreshing to read of the immense inroads made by fishes upon the larvæ, by dragon flies and by birds, six hundred mosquitoes having been found in the crop of a single night hawk, but it will afford the reader still more satisfaction to know how easily these dangerous pests can be exterminated by the use of so simple a remedy as petroleum. On the last subject the book is strong.

A. S. PACKARD.

SOCIETIES AND ACADEMIES.

THE AMERICAN CHEMICAL SOCIETY.

THE following is a list of the papers thus far offered for the joint meeting of the American Chemical Society and Section C of the A. A. A. S. to be held in Denver during the last week in August:

1. 'Solid Hydrocarbons of the Series C_nH_{2n+2} and Liquid Hydrocarbons of the Series C_2H_{2n} in the Less Volatile Portions of Pennsylvania Petroleum' (by title): CHARLES F. MABERY.

2. 'Specific Heats and Heats of Volatilization of Hydrocarbons of the Series C_nH_{2n+2}, C_nH_{2n}, and C_nH_{2n-4}, in Pennsylvania, Texas, California and Japanese Petroleums' (by title): CHARLES F. MABERY.

3. 'Composition of Commercial Paraffine, Vaseline, and Solid and Pasty Mixtures of Hydrocarbons, collected in Oil Wells' (by title): CHARLES F. MABERY.

4. 'Composition and Properties of Asphalts from Different Petroleums' (by title): CHARLES F. MABERY.

5. 'Analysis of a Few Southwestern Coals' (10 min.): HERMAN POOLE.

6. 'Summary of Analyses of the Massive Rocks of Boulder County, Colorado': CHARLES S. PALMER.

7. 'The Indirect Weighing of Quantitative Precipitates' (by title): R. W. THATCHER.

8. 'An Automatic Filter Washer' (20 min.): J. M. PICKEL.

9. 'Some New Laboratory Furniture': PROF. LACHMAN.

10. 'Recent Developments in Physical Chemistry': WILDER D. BANCROFT.

11. 'Proper Methods of Teaching Physical Chemistry': WILDER D. BANCROFT.

12. 'Some Points on the Teaching of Chemistry': CHARLES S. PALMER.

13. 'What Constitutes Instruction in Technical Chemistry' (15 min.): EDWARD HART.

14. 'Discussion of Methods used in Different Universities for Giving Instruction to Large Classes in Elementary Laboratory Work': WM. MCPHERSON.

15. 'The Teaching of Chemistry in Secondary Schools': FREDUS N. PETERS.

16. 'Chemistry in Manual-Training High Schools' (15 min.): ARMAND R. MILLER.

17. 'The Determination of Sulphur in Iron and Steel' (15 min.): WM. A. NOYES and L. LESLIE HELMER.

18. 'Copper as allied to the Sciences, and its Commercial Value' (7 min.): W. S. EBERMAN.

19. 'On the Decomposition of Sodium Nitrate by Sulphuric Acid'—Part III.: C. W. VOLNEY.

20. 'Quantitative Determination of Hydrofluoric Acid' (3 min.): W. E. BURK.

21. 'Methods of Standardizing Acid Solutions' (15 min.): CYRIL G. HOPKINS.

22. 'The Sulphohalides of Lead' (10 min.): VICTOR LENHER.

23. 'Hydrochlorated Mercury and Cadmium Sulphates' (5 min.): CHARLES BASKERVILLE.

24. 'Evidences of the Probable Complexity of Thorium' (10 min.): CHARLES BASKERVILLE.

25. 'Constitution of Alloys': J. A. MATHEWS.

26. 'Cryoscopic Experiments with Sulphur' (12 min.): ALEXANDER SMITH.

27. 'The Electrolytic Method applied to Uranium' (15 min.): LILY GAVIT KOLLOCK and EDGAR F. SMITH.

28. 'The Electrolytic Determination of Molybdenum' (15 min.): LILY GAVIT KOLLOCK and EDGAR F. SMITH.

29. 'The Precipitation and Separation of Silver in the Electrolytic Way' (15 min.): W. H. FULWEILER and EDGAR F. SMITH.

30. 'The Electrolytic Separation of Mercury from Copper': C. ROSCOE SHAW and EDGAR F. SMITH.

31. 'The Identification and Properties of Alpha- and Beta-Eucaine' (15 min.): CHARLES L. PARSONS.

32. 'A Comparison of the Solubility of Acetylene and Ethylene' (15 min.): SAMUEL AUCHMUTY TUCKER and HERBERT R. MOODY.

33. 'On the Estimation of Urea in Urine' (10 min.): JOHN H. LONG.

34. 'On the Determination of Formaldehyde' (15 min.): A. G. CRAIG.

35. A Modification of the Sulphuric Acid Test for Formaldehyde in Milk' (5 min.): A. GUSTAV LUEBERT.

36. 'The Synthesis of Ketodihydroquinazolins from Anthranilic Acid' (by title): AUGUST HENRY GOTTHELF.

37. 'Researches on Nitrocellulose' (by title): G. LUNGE.

38. 'The Reduction in an Alkaline Solution of 2.4.5. Trimethylbenzaldazine' (20 min.): E. P. HARDING.

39. 'Preparation of 2.5. Dimethylbenzaldehyde; the Estimation and Preparation of some of its Derivatives': EVERHART P. HARDING and LILIAN COHEN.

40. 'A Study of the Chemical Composition of Meat Extracts' (10 min.): H. S. GRINDLEY.

41. 'Chemical Changes Produced by the Action of Bacteria' (10 min.): H. S. GRINDLEY.

42. 'Derivatives of Diphenyl Ether' (25 min.): A. N. COOK.

43. 'The Constitution of Azoxybenzine': PROFESSOR LACHMAN.

44. 'The Action of Zinc Ethyl on Nitro and Nitroso Compounds—a Reply to I. Bewad': PROFESSOR LACHMAN.

45. 'Recent Developments in Organic Chemistry': PROFESSOR LACHMAN.

DISCUSSION AND CORRESPONDENCE.

PSEUDOSCOPIC VISION.

THE experiment described by Professor Wood (SCIENCE, August 2, p. 185) is always striking and attractive when performed for the first time, and he is probably only one of many who have attained this binocular result independently. I did so twenty years ago; and my attention was called to such phenomena more than thirty years ago by the late Professor Joseph LeConte.

But the use of the unaided eyes for the at-

tainment of either orthoscopic or pseudoscopic binocular effects was described by Sir David Brewster as long ago as 1844 (*Edinburg Transactions*, 1844, Vol. XV., Part III., p. 360), and quite fully discussed in his book on 'The Stereoscope,' published in 1856. On the optical illusions due to cross vision Brewster based his geometric theory of binocular vision, which was fully elaborated in his book. In 1855 and 1856 the same theory was applied by Professor W. B. Rogers, founder of the Massachusetts Institute of Technology, in a series of articles published in the *American Journal of Science*. It has since been applied by various writers. The incorrectness of this theory is conclusively proved by the possibility of binocular vision by optic divergence (*Am. Jour. Science*, Nov. and Dec., 1881, March, April, May, Oct. and Nov., 1882).

Nevertheless, the subject is attractive, and the results attainable when the visual lines are made to cross at a high angle, such as 50° or 60°, suggest some interesting and perfectly legitimate geometric applications. But these experiments are somewhat trying to the muscles of the eyes.

W. LE CONTE STEVENS.
WASHINGTON AND LEE UNIVERSITY,
August 3, 1901.

SHORTER ARTICLES.

ADAPTATION IN VISION.

APPARENTLY no one has noticed formally the bearing upon brain physiology of one of the commonest phenomena of vision. Within certain very wide limits the percept we have of any object does not change at all while we approach or recede from it. If, for instance, I look at a chair thirty feet off and then walk straight toward it, the appearance of the chair does not alter. Now the retinal elements excited are totally different according to the distance I am from the object. We have then a succession of different physiological processes in the retina with the final result in consciousness of a constant feeling. We naturally suppose that a continuance of the same feeling is due to a continuance of substantially the same physiological processes in the central nervous system. If this is true we can account for the phenomenon mentioned only by supposing that all the differing successive processes in the end organ somehow get shunted into the same central process. This involves a practical infinitude of associative systems of the subtlest and most complex sort. For with each of the objects of which we thus have a constant perception in spite of varying retinal conditions, different sets of associations are needed corresponding to different views of the object. Moreover, totally new objects suffer like treatment. This latter fact almost tempts one to put faith in a mysterious mental construction on the basis of sense stimuli. Surely if the brain itself does the work of unifying these multitudes of series of retinal events into constant processes corresponding to our percepts, the complexity of its mechanism has never been fairly stated. This, I take it, is what we must believe. We must find in this commonest case of vision a notable example of the fact that our feelings do not parallel outside events or even the sensory processes aroused by them, but are the results of selected adaptations, adaptations in this case presupposing much more involved neural action than the common reflex-arc conception of the brain seems to permit.

EDWARD L. THORNDIKE.
TEACHERS COLLEGE, COLUMBIA UNIVERSITY.

THE INJURY OF FUNGICIDES TO PEACH FOLIAGE.

THE writer has devoted several seasons to an investigation of the injury produced by fungicides to peach foliage. A bulletin giving the results of this work is soon to appear from the Tennessee Agricultural Experiment Station. A preliminary report on this investigation may not be out of place here. Following are some of the points established or rendered probable:

1. Pure copper hydroxide, copper oxide, or even metallic copper spread on the leaves is injurious to the foliage of the peach, but without visible injury to that of either the apple or the grape.

2. A solution of copper sulphate 0.00005 normal (=0.000795 per cent.) proved fatal to water cultures of the apple, while grapes and peaches under like conditions, though evidently injured, soon recovered, and the peaches thus

treated on October 8 remained alive over winter.

3. Peach foliage protected from rain and dew, as in a greenhouse, sustains no externally visible injury from spraying with either Bordeaux mixture or copper hydroxide. Under normal orchard conditions the leaves sprayed with Bordeaux in a situation so as to be partially protected from falling rain or dew are the last to succumb to the injurious action of the copper.

4. The presence of deliquescent salts (as $Ca(NO_3)_2$ and $CaCl_2$) greatly accelerates the injurious action of copper hydrate on the foliage of the peach.

5. Peach seedlings growing in a saturated atmosphere are not injured by Bordeaux mixture and but slightly by pure copper hydrate.

6. Peach leaves growing in a saturated atmosphere possess a thinner and much more easily permeable cuticle than those growing in a dry or less moist atmosphere. Following is a summary of measurements of paraffine sections stained with chloroiodide of zinc:

Peach leaves.	Thickness of cuticle of upper surface.
Orchard Knoxville.....1.17	micromillimeters
Orchard California.....1.21	"
Seedling greenhouse.....0.86	"
Seedling in moist chamber.....0.60	"

7. The presence of a certain excess of lime accompanying the copper hydrate on peach foliage retards or possibly entirely prevents the injurious action of the latter. This holds true of lime applied either as the hydrate or at once as the carbonate. The sulphate of lime does not produce this effect.

The writer believes that the above results go far toward explaining the conflicting testimony of different investigators along this line in this country. So far as shown to date, no injury will result to peach foliage sprayed with ordinary Bordeaux mixture until a certain proportion of the lime carbonate is washed out by heavy dews or rain, when it at once begins to manifest itself. One would thus expect but little injury in an arid region like parts of California. On the other hand, an atmosphere containing abundant hygroscopic moisture, such as is to be found in Georgia and Florida, would supply conditions similar to those produced in the moist chamber as stated above, and thus atone to a certain extent for the washing out of calcium carbonate caused by precipitated water.

The practical application of this principle is readily suggested. It may be possible to follow up a spraying with Bordeaux mixture with one or more of milk of lime and thus prevent the injury which would otherwise occur. Experiments carried out here this season thus far show this method to be a success. Whether it will remain so to the end of the season is yet to be determined. There are, of course, other questions to be taken into consideration, such as the practical application of the method in the commercial orchard, the effect of the lime on the fungicidal action of the copper, etc.

It is hoped in the forthcoming publication above mentioned to describe in detail the experiments above outlined, in addition to a number of others finished and now nearing completion, looking toward the physiological explanation of the results obtained.

Samuel M. Bain.
University of Tennessee, Knoxville.

CURRENT NOTES ON PHYSIOGRAPHY.

THE NORTHERN ADIRONDACKS.

A 'Preliminary Report on the Geology of Franklin County,' N.Y., by H. P. Cushing (18th Rep. State Geol., Albany, 1900, 73–128, 8 pl., colored outline map) describes the northern side of the Adirondack mountains and the drift-covered paleozoic plain at their base. The transition from one area to the other is rather abrupt, but the height of the mountains decreases with some regularity towards the plain, and branches of the plain enter valleys among the hills. An old baselevel is inferred from the systematic northward decrease of summit heights, although its horizon is admittedly not closely definable. The present valley system is explained as of later origin, the result of erosion following a slanting uplift. No dates are given in this connection, although it is said that 'the Adirondack region has been continuously above sea level since Lower Silurian times' (78), a statement that seems open to doubt. The step-like descent of the mountains toward Lake Champlain is explained 'by a

series of meridional faults with downthrow to the east,' and the depression occupied by the lake itself is said to be 'a fault valley.' It is not stated whether these faults, more or less worn, are yet so recent that they dominate the topography, or whether they are ancient faults produced while yet a heavy series of strata overlay the present surface, and only developed into existing topographic features by erosion long subsequent to faulting. Glacial erosion is regarded as having rounded off the northern slopes of many of the mountains, leaving the southern slopes of greater declivity; and a few cliff-walled cirques are ascribed to local glaciers. Lakes are very numerous and are as a rule referred to drift obstruction; 'there is yet no evidence that any of them occupy rock basins' (84). The rivers have all developed reaches ('still-waters' or 'levels') on drift, interrupted by rapids on ledges. The drift plain bordering the mountains is well occupied, while the mountains are largely a rugged wilderness.

SLATE MOUNTAINS OF THE MIDDLE RHINE.

THE report of an excursion conducted by Professors Rein and Philippson over the plateaus and valleys of the middle Rhine ('Wiss. Ausflug, Siebengebirges-Rhein-Eifel-Mosel,' 19–25 Sept., 1899; Verhandl. VII. Internat. Geogr. Kongresses, Berlin, 1900, 328–344) presents some interesting details concerning that attractive region, its physiographic features being described by Philippson. The lofty mountains of Carboniferous deformation were reduced, partly by subaerial denudation, partly by marine abrasion, to a low torso, afterwards broken into blocks which were irregularly elevated and depressed. The Rhine crossed the region along a depressed block, whose surface it modified, producing a broad trough, which now stands at altitudes of 300–350 m. The Mosel eroded a branch trough, whose altitude is now 350–400 m. Pauses in the uplift of the region to its existing position are indicated by terraces, of which the principal one, strewn with river waste, reaches heights of 200 m. It is in the floor of this terrace that the narrow gorges of the Rhine and Mosel are cut. Troughs, terraces and gorges are the work of Pliocene and later time. Frequent mention is made of the extended views over the plateau in which the troughs and the deeper valleys have been cut, of the volcanic cones and maare that ornament it, and of the ridges of resistant quartzite that rise over it. Yet it is concluded that the plateau is not a peneplain and that its history is still to be made out. Truly it is not a peneplain, everywhere almost completely worn down and still lying undisturbed close to sea-level; but the description given of it strongly suggests that it is a somewhat unevenly uplifted peneplain, bearing some linear residual mountains on its back, and more or less dissected by its revived streams. For example, "The High Eifel is a broad, flat-arched dome, which descends southward as a gently inclined plain towards the valley of the Mosel; beyond the Mosel, the same surface is continued in the Hunsrück as a nearly horizontal plain, rising wall-like in the high quartzite ridges of the Hochwald" (p. 332). To exclude a region thus described from the class of uplifted and dissected peneplains makes one wonder what conception the author attaches to this category of forms. The report forms a very serviceable guide for a physiographic excursion over this district. It is in many ways more satisfactory than the more elaborate essays by Follman on the Eifel and by F. Meyer on the Hunsrück (*Forsch. deut. Landes und Volkskunde*, VIII., 1894, 195–282; XI., 1899, 73–106), which unfortunately leave much to be desired in this respect.

PHYSIOGRAPHY OF ACADIA.

THE general progress of physiographic development that has been found applicable to the Appalachian belt within the United States by various observers is extended by Daly to the provinces of New Brunswick and Nova Scotia with the adjoining islands ('The Physiography of Acadia,' *Bull. Mus. Comp. Zool., Harvard Coll.*, XXXVIII., 1901, 73–104, 10 pl., map). The uplands of inner New Brunswick and the 'southern plateau' of Nova Scotia are regarded as areas of Cretaceous peneplanation, now uplifted and dissected; while central New Brunswick, together with certain areas now submerged in bays, represent lowlands etched out of weak rocks beneath the Cretaceous peneplain, and now partly drowned. The author

concludes that Acadian land forms may be described in terms of these two topographic facets, each a nearly perfect plain of denudation, interrupted by residual hills and incised valleys. Regarding the uplands of Nova Scotia, it is remarked that undue emphasis has been placed on the hills, "apparently with the mistaken notion that the true lover of nature cannot be especially interested in her land-forms when they are subdued. Yet the marvel of Nova Scotian scenery lies in its flatness." Although the region borders the sea, preference is expressed for a subaerial origin of the peneplains here described; marine erosion is given a relatively subordinate value in their preparation, however active it has become upon them since submergence has brought the sea in over the land.

PREGLACIAL DRAINAGE OF OHIO.

Several papers on 'The Preglacial Drainage of Ohio' by Tight, Bownocker, Todd and Fowke are published by the Ohio State Academy of Science (Special papers, No. 3, Dec., 1900, 75 pp., plates and maps). Tight describes some of the drainage changes along a part of southeastern Ohio, with special references to the preglacial and postglacial valleys that lie to the southwest of the trenched col by New Martinsville, from which the preglacial streams flowed opposite ways and through which the Ohio now connects basins that were formerly separate. A high-level and broad-floored ancient valley is traced through the hills southwest of Parkersburg; it is now trenched across by several deeper-cut valleys. The most novel point is presented by Fowke, regarding a former northward discharge through the Miami valley of the waters from several rivers (Licking, Kentucky, etc.) whose courses lie between ancient cols at Manchester and Madison, east and west of Cincinnati. The northward discharge is now blockaded by drift; the cols are cut across by the Ohio, and the gathered rivers are discharged westward. This involves an impounding of many north-flowing rivers by the ice sheet and the production of a temporary lake, compared to which the reputed lake caused by the supposed ice dam at Cincinnati would have been a comparatively small affair. Independent evidence of the existence of the lakes is not yet announced. Both Fowke and Todd suggest that some of the preglacial streams followed courses that were determined in paleozoic time, a suggestion that seems to give too little importance to the many possible changes of secondary and tertiary time.

The technical book-making of this publication is not altogether creditable to a State Academy. There is no table of contents, except an imperfect one on the paper cover, which disagrees with the title page and with the titles of some of the articles; the same page heading is continued throughout; some of the maps are unnumbered, and all of them are poorly lettered.

SCHLESWIG-HOLSTEIN.

An east-west section across the base of the Danish peninsula is described by R. Gredner ('Excursion nach Ost-Schleswig-Holstein und der Insel Sylt.,' Greifswald, 1900), from which it appears that the chief features of the district are systematically arranged with respect to the glacial moraine that forms its strongest relief. The eastern border shows the hills and hollows of the typical moraine, of rich soil and divided into well-cultivated fields by numerous hedges. The eastern shore line is irregular in consequence of a slight postglacial submergence; embayments known as Föhrde (etymologically related to fjords and firths) occur where interglacial valleys were deepened by scouring ice lobes; they lead navigable water in among the morainic hills, thus locating such towns as Flensburg and Kiel. Beyond the moraine comes a broad plain of washed sands and gravels, sloping gently to the west and traversed by shallow channels; it is covered with pine forests or heathery moors, and is infertile and thinly occupied compared with the moraine. As the plain slopes westward, its materials become finer and ground water stands nearer its surface; thus the moors become meadows, and at last dikes are needed along their borders to hold off high tides. The shallow edge of the sea is known as the Wattenmeer, where a great expanse of fine mud, traversed by winding channels, is laid bare at low tide. Fields are occasionally gained by diking in the shallowest

border of the tidal flats. The outlying islands, of which Sylt is here described, consist of remnants of Tertiary strata, overlaid by drift. Long wings of beach and dunes stretch north and south from the western front of the island, with slightly convex outline towards the North sea and in-bent hooks at their end. The wings are much longer than the front of the island from which they are spread.

W. M. DAVIS.

JESSE WILLIAM LAZEAR MEMORIAL.

ON the 25th of September, 1900, Jesse William Lazear, at that time Acting Assistant Surgeon in the United States Army and a member of the Government Commission for the investigation of yellow fever, lost his life from that disease at Quemados, Cuba.

Doctor Lazear was born in Baltimore County, Maryland, in 1866, and graduated from the academic department of the Johns Hopkins University in 1889. In 1892 he received the degree of M.D. from Columbia University. From 1892 to 1895 he spent his time in study and investigation in Europe and as an interne at the Johns Hopkins Hospital in Baltimore. During the following three years and a half, while a member of the staff of the Out-Patient Department of the Johns Hopkins Hospital, he did much valuable work as a teacher and investigator in the laboratory of clinical pathology. In February, 1900, induced by the opportunity for research concerning malarial and yellow fevers, Lazear became an acting assistant surgeon in the United States Army and was assigned special laboratory duties at Columbia Barracks, near Havana. Later, he was appointed member of a special government commission for the investigation of yellow fever. The brilliant discoveries of this commission concerning the ætiology and manner of infection of yellow fever have recently been referred to in public by a distinguished pathologist as the most important piece of work by American students since the discovery of anæsthesia. To these results Lazear, as a member of the commission, contributed largely. The final proof of their discovery that the disease is transferred by the bite of a certain mosquito could only be obtained by direct experiment upon a human being. To this experiment Lazear, with another of the committee, courageously and heroically subjected himself, and in the performance of this noble duty he lost his life.

The many friends and admirers of the talented and accomplished student, of the brave, true, self-sacrificing man, desire to establish a lasting memorial to him and to his work. To this end a meeting was held on the evening of Wednesday, May 22, which was presided over by Professor William Osler. At this meeting it was concluded that the nature of the memorial could better be decided upon when some idea could be obtained as to the amount of money available. It was, therefore, decided that a committee consisting of Dr. Stewart Paton and Dr. William S. Thayer be appointed to arrange for the distribution of a circular among the friends and admirers of Lazear, setting forth the object of the meeting. It is earnestly hoped that not only those who have known and admired Lazear and his work, but also others, who appreciate courage and manliness and self-sacrifice, may contribute to the fund for the Jesse William Lazear Memorial.

Subscriptions may be sent to Dr. Stewart Paton, treasurer, 213 West Monument Street, Baltimore, Md. It is to be hoped that the response to this circular may be made early, as it is hoped to be able to decide upon the nature of the memorial by the middle of June.

WILLIAM OSLER, *Chairman.*
STEWART PATON,
WILLIAM S. THAYER, } *Committee.*

THE AMERICAN LIBRARY ASSOCIATION.

AT the annual meeting of the American Library Association, held at Waukesha, Wis., the 3d to 10th of July, a Round Table meeting was devoted to professional instruction in bibliography. The chairman, Mr. A. G. S. Josephson, of Chicago, in his introductory remarks, pointed out the need of solid bibliographical scholarship as a prerequisite of the librarian and urged the establishment at some university of a post-graduate school of bibliography. Such a school should, in the opinion of the speaker, offer instruction in bibliography

proper—*i. e.*, knowledge of the repertories and the record literature; classification of knowledge and history of science as the foundation of the classification of books; bibliographical methodology—*i. e.*, the principles of cataloging; history of libraries and library administration; history of printing and publishing. A communication had been received from Dr. Med. J. Leche, of Göttingen, assistant to Professor C. Dziatzko, outlining the course of bibliography given by the latter. This outline was supplemented by reminiscenses from a sojourn at Göttingen by Mr. A. S. Root, librarian and professor of bibliography at Oberlin College, who also spoke of the courses given by himself. Mr. G. W. Harris, of Cornell, and Mr. J. I. Wyer, of Nebraska, told of courses given by them. A most important contribution to the discussion was made by Professor Charles H. Haskins, of the University of Wisconsin, who not only told of the course in historical bibliography given by himself, but enlarged on the importance of bibliographical studies, not only for librarians but for scholars in general. He heartily endorsed the views of the chairman in regard to the importance of a special school of bibliography.

Several speakers, among them the librarian of the John Crerar Library, Chicago, Mr. C. W. Andrews, spoke of the difficulty of obtaining for library service men trained in science and at the same time familiar with bibliographical and library methods.

MR. CHAMBERLAIN ON THE FUNCTIONS OF A UNIVERSITY.

At the first congregation of the University of Birmingham, Mr. Chamberlain made an address in the course of which, as reported in the London *Times*, he said: What should constitute an ideal university? It may be presumptuous in me to attempt a definition, and yet when we are at the outset of our career it is necessary, it is desirable, that we should have some clear conception of the standard at which we are going to aim. And I would venture to lay down four qualifications as necessary to a perfect university. In the first place, it should be an institution where all existing knowledge is taught. Such a university may, perhaps, never yet have been attained; want of means may always prevent it, but at least that is the object at which we should aim, and we should never rest satisfied until we can say that no student desirous of instruction in any branch of learning shall be turned hungry away from the doors of this University. No doubt the enormous development of knowledge, and especially of its scientific side, during the present century requires a certain specialization in the teaching of that knowledge, and I think it may be desirable, I think it may be necessary, that universities also should be specialized, and that one university should pay more attention than another to particular studies; but I believe at the same time that it would be fatal if in our desire as a modern university to give a special development to the practical and thorough teachings of our scientific work, it would be a great mistake, I say, if we were to exclude or to neglect the older branches of learning. Well, then, in the second place, a university is a place where the knowledge that has been acquired has to be tested. And as to that I will only say that in the multiplication of examining bodies I hope that nothing will be done, either by us or by our successors, to lower the standards of proficiency, whether in the ordinary pass or in the highest honors. I conceive that common prudence should teach us to keep up the value of the degrees which we have begun to confer to-day, and nothing would be more unwise, more fatal to our reputation and to our ultimate success than that we should endeavor to multiply the number of our students at the expense of their quality. Then the third feature to which I should call attention, and which I am inclined to say is the most important of all, is that a university should be a place where knowledge is increased and where the limits of learning are extended. Original research, the addition of something to the total sum of human knowledge, must always be an essential part of our proposals. We want to secure that those who teach in this University shall never cease to learn, and that those who are students shall unite with them in the work of fresh and new investigation. And, lastly, a university is a place where the

application of knowledge must be indicated and directed. That perhaps brings us nearer to what may yet be the distinctive feature of our University. At all events we start with the belief that here we are going to combine theory with practice, and to see that in our University we shall combine both in one course of instruction, with due regard to the needs of our own time and of our own district. And now, if I may summarize in one sentence what I have been saying, it is that a university should be a place where knowledge is taught, tested, increased and applied.

PROFESSOR STARR'S RECENT WORK IN MEXICO.

WITH his last journey to Mexico, which extended over four months, Professor Frederick Starr brings the field-work of four years' study of Mexican Indians to a close. This study has had for its object the careful definition of the physical types of the tribes of southern Mexico. Three kinds of work were done—measurement, photography and modeling. In each tribe one hundred men and twenty-five women were measured, fourteen measurements being taken of each individual. Photographic portraits were taken of typical subjects, a front view and a straight profile being made of each. Busts in plaster were made of those who appeared most perfectly to present the racial type, the molds being made directly upon the subject. During the four seasons over which his work has extended Professor Starr has visited the following twenty-three tribes: Otomis, Tarascans, Thaxcalans, Aztecs, Mixtecs, Triquis, Zapotec-Mixtecs, Mixes, Tehuantepec Zapotecs, Juaves, Chontals, Cuicatecs, Chinantecs, Chochos, Mazatecs, Tepehuas, Totonacs, Huaxtecs, Mayas, Zoques, Tzendals, Tzotzils and Chols. While the physical types of the natives formed the chief subject of study, many views were also taken of the scenery, villages, houses, groups of Indians, native industries, etc., etc. The material results of the investigation include measurements from 2,850 persons, 1,200 or more negatives, varying in size from 8 x 10 inches to 4 x 5, 100 busts in plaster, and a large collection of objects—dress, weapons, implements and products—illustrating the ethnography of the region. Several months will be necessary for putting all this material into shape for exhibition and publication. The printed results of the study will comprise five volumes. Of these, two will be albums of plates, illustrating the people and the country, under the title 'The Indians of Southern Mexico,' two will be pamphlets, printed by the Davenport Academy of Natural Sciences, entitled 'Notes on the Ethnography of Southern Mexico,' the fifth will probably be issued as a bulletin of the Department of Anthropology by the University of Chicago, and will present the results of the anthropological measurements and observations under the name of 'The Physical Characters of the Indians of Southern Mexico.' The first volume of the 'Indians of Southern Mexico,' and part first of the 'Notes on the Ethnography of Southern Mexico' have already been published. The remaining three volumes will be printed as soon as possible. It may be added that this work of Professor Starr is the first of its kind undertaken in Mexico.

SCIENTIFIC NOTES AND NEWS.

DR. PATRICK MANSON, F.R.S., has been awarded the Stewart prize of the British Medical Association, for his researches in the pathology of tropical diseases, especially in regard to the malaria of man and to the life-history of the malarial parasite both in man and in the mosquito, and in recognition also of the stimulating influence which he has exerted for many years on the study of tropical diseases in the British Empire.

PROFESSOR KOCH was entertained at dinner on July 24, by the Royal Institute of Public Health and was presented with the Harben medal for 1901. The presentation was made by Dr. W. R. Smith, president of the Institute, who was in the chair.

The British Medical Journal states that among the honors to be paid to Professor Rudolf Virchow on the occasion of his eightieth birthday will be the foundation of a *Virchow Haus*, at Berlin, with objects similar to those of the *Hofmann Haus*, which serves as a club house, library, etc., for chemists.

THE Royal Society has elected Professor Franz von Leydig, of Bonn, a foreign member.

THE University of Basle has conferred the honorary degree of Ph.D. on Dr. Robert Billwiller, director of the Meteorological Institute of Bonn, and on Professor Alfred Wolfer, director of the Astronomical Observatory at Zurich.

WE learn from *Nature* that the French Société d'Encouragement pour l'Industrie nationale announces the following awards of prizes: Grand gold medal to the Chamber of Commerce of Lyons for the organization of the commercial mission to China; 2,000 francs to M. Horsin-Déon for his work on beet root sugar; 500 francs to M. R. Fosse for his works on β-dinaphthol, and the same amount to M. Marcel Guichard for his works on molybdenum; 1,000 francs to M. Triboudeau for his study of the Pas-de-Calais, and 1,000 francs each to MM. Faure and Thénard for memoirs on the utilization of waters in agriculture.

THE Council of the Royal Society has awarded the Mackinnon studentship to Mr. J. J. R. Macleod, M.B., demonstrator of physiology in the London Hospital Medical College, for the purpose of enabling him to carry out researches in pathological chemistry. The studentship is founded under a bequest to the Royal Society by the late Sir William Mackinnon, director general of the Medical Department of the Army, for the foundation and endowment of prizes or scholarships for the special purpose of furthering natural and physical science, and of furthering original research and investigation in pathology. There were fourteen applications for the studentship which is of the annual value of £150.

MR. H. N. WHITFORD has been appointed collaborator in the Bureau of Forestry, U. S. Department of Agriculture.

C. E. VAN ORSTRAND, of the Nautical Almanac Office, has been transferred to be assistant physical geologist in the U. S. Geological Survey.

GOVERNOR STONE, of Pennsylvania, has appointed Miss Myra L. Dock of Harrisburg a member of the State Forestry Commission.

PROFESSOR J. BEHRENS has been appointed director of the agricultural experiment station at Augustenberg, in Baden, and Dr. R. Meissner, of Geisenheim, director of the station for grape culture at Weinsberg, in Würtemberg.

MR. HARLAN I. SMITH, of the American Museum of Natural History, has returned from a trip through the lower peninsula of Michigan, where he made a survey of the recently discovered 'Hauptman Earthwork,' a few miles southwest of West Branch, Ogemaw County. Three camp sites were also discovered along Indian River in Cheboggan County.

DR. A. W. NIEWENHUIS, medical officer of the Dutch colonial army, is at present in San Francisco, after having spent several years in scientific exploration in Borneo.

DR. FELIPE CALDAS, the Brazilian bacteriologist, sailed on July 24, for Cuba, accompanied by Dr. Angel Bellinzaghi, his assistant. They will conduct experiments with the serum that Dr. Caldas discovered.

PROFESSOR HERBERT B. ADAMS, who was connected with the department of history of the Johns Hopkins University since the opening of the University in 1876, has died at the age of fifty-one years.

DR. P. CALVIN MENSCH, since 1894 professor of the biological and chemical sciences at Ursinus College, at Collegeville, Pa., died on July 30.

CHARLES MOHR, Ph.D., whose death at his home in Asheville, N. C. we announced last week, was for many years connected with the U. S. Department of Agriculture, as special agent of the Forestry Division, and with the Geological Survey of Alabama, as botanist. His most important works during the past ten years have been: A study for the Forestry Division of the long leaf pine, a monograph on which was recently published by the Department of Agriculture; The 'Plant Life of Alabama,' a systematic account of the flowering plants and ferns growing without cultivation in Alabama; and 'The Botanical Resources of Alabama,' being an account of the useful and noxious plants of the State. The 'Plant Life of Alabama' was prepared under the joint auspices

of the U. S. Department of Agriculture and the Geological Survey of Alabama, and is now in press and about ready for distribution as a Bulletin of the Botanical Division of the Department. It will also be published as a report of the Geological Survey of the State. The volume on the economic botany of the State was being prepared for the Geological Survey, and was only partly in manuscript. The death of Dr. Mohr before the completion of this report must be counted as a misfortune both to the State of Alabama and to science in general, since there is no one else so well qualified as Dr. Mohr to write upon this subject. The collections in the Museum of the University of Alabama, in great part brought together, arranged and installed by him, will remain as enduring monuments to his memory. These are: A collection of dried specimens of the flowering plants and ferns of Alabama representing some 2,500 species; a similar collection of the mosses, liverworts, lichens and fungi of the State, numbering some 1,000 species; a forestry collection, consisting of about 150 blocks in book form illustrating the native woods, and a collection in about 150 individual glass front cases, showing the foliage, flowers and fruits of the timber trees of the State.

THE British Medical Association held its sixty-ninth annual meeting at Cheltenham last week, under the presidency of Dr. G. B. Ferguson.

The Botanical Gazette states that, under a commission from the United States Government, Dr. H. von Schrenk, of the Shaw School of Botany at St. Louis, is to spend the summer in Europe, in an investigation of the problems connected with the decay of railroad ties on the principal roads, this work being done in connection with a series of investigations on the same subject which he is undertaking for the U. S. Department of Agriculture, in which the principal American railroads are cooperating.

As we learn from the same source, Dr. J. N. Rose left about June 20 for his third botanical trip to Mexico. He expects to go first to the City of Mexico, working out from this point as a base southward towards Acapulco and eastward toward Vera Cruz, probably ascending Mount Orizaba and Popocatepetl. The objects of his trips are to make a general botanical collection; to collect at type localities certain species of Humboldt, Galeotti, Schiede and other early collectors; and to acquire information in regard to the economic uses of Mexican plants, especially such as will supplement a second paper on the useful plants of Mexico which is now nearly completed.

THE examination for the position of assistant ethnologist in the Bureau of American Ethnology, recently announced in this journal, was passed creditably by Albert Ernest Jenks, Ph.D., of Madison, Wisconsin, and he has just been appointed to the position and assigned to work on the foods and other economic resources of the Amerind tribes about the Great Lakes.

WE are requested to state that the fossil vertebrates, to which we recently referred as having been collected under the auspices of the U. S. Geological Survey in the Triassic of Arizona were collected by Mr. Barnum Brown. They filled two boxes weighing nearly half a ton, and have been unpacked under the direction of Mr. F. A. Lucas, who will probably soon report as to their scientific value.

A CASE of the bubonic plague is at present on Swinburne Island, New York City, having been removed from a steamship that arrived in the port from Calcutta. The case was diagnosed by the quarantine laboratory and the diagnosis confirmed by the marine hospital service. The disease has not been exterminated in San Francisco and appears to be spreading at Capetown and in Egypt.

THE Liverpool School of Tropical Medicine will send another expedition, probably under the direction of Dr. Annett, to Sierra Leone. This is the seventh expedition sent by the school for the investigation of malaria.

THE British National Antarctic Expedition steamship *Discovery* left London on July 21. She will proceed to Spithead to complete her equipment and will stop at Cowes, where the King will bid good-bye to the members of the expedition.

A TELEGRAM from Reuter's Agency states that the St. Petersburg Academy of Science re-

ceived, on July 11, a telegram from the leader of the expedition which is shortly to bring to St. Petersburg the mammoth found in Siberia. The telegram, which is despatched from Yakutsk, reports that the expedition arrived at that place on June 14. It is proceeding by steamer up the river, and will then journey overland to Kolymsk, which is 3,000 versts off, and where it expects to arrive in two and a-half months. The mammoth found is unique of its kind. Its hair, skin and flesh are entirely preserved, and there are remains of undigested food in its stomach.

The University of Montana biological collecting expedition has spent five weeks in the mountains of the State, and four weeks more are being devoted to the work of the station on Flathead lake. During the trip several peaks have been ascended in the Mission and Kootenai ranges, and new names have been given to a number of unnamed peaks. Dr. Henry C. Cowles, of the University of Chicago, with a party of about twenty students, will spend ten days at the station studying the botany of the region. The work of the station will close August 16, when the instructors will attend the Denver meeting of the American Association.

A report of the Geological Survey on the operations of the Kowak River party in Alaska has been submitted by Mr. Mendenhall, the geologist in charge of the work. He says the party reached Dawson, Yukon Territory, on June 4. Mr. Reaburn, of the party, with three camp hands, immediately began to survey a line from Fort Yukon to the mouth of Dall River, approximately 150 miles. This region of the Yukon flats offered no geologic problems other than those involved in the history of a large area of fluvial silts.

The Council of Birmingham University has agreed to subscribe to a working 'table' at the Port Erin (Isle of Man) biological station, under Professor Herdman, to be placed at the disposal of Professor Bridge, for the use of his senior students when studying marine organisms, one student to occupy it for a month or more at a time.

During the opening week of the Minnesota Seaside Station on the west coast of Vancouver Island, evening lectures were delivered as follows:

Professor Conway MacMillan, Univ. of Minn.: 'Waste in Nature.'

Mr. K. Yendo, Univ. of Tokio: 'Distribution of Algæ in Japan.'

Mr. Harold Lyon, Univ. of Minn.: 'Phylogeny of the Cotyledon.'

Professor Conway MacMillan, Univ. of Minn.: 'Laminariaceæ of the Straits of Fuca.'

Miss Eloise Butler, Central High School, Minneapolis: 'Collecting Seaweeds in Jamaica.'

Dr. Francis Ramaley, Univ. of Colorado: 'Distribution of Plants in Colorado.'

The new seaside station has had in attendance during its first season thirty students, most of whom have specialized in botany, but some zoological work has also been done.

Professor B. E. Fernow, director of the New York State College of Forestry, Cornell University, and formerly chief of the U. S. Division of Forestry, gave a course of lectures at the University of Chicago, beginning June 24. He treated forestry in its botanical, practical and political aspects. The subjects were as follows:

'What is Forestry?' (Economic significance of forest resources and need for their management; definition of terms and historic development of the art of forestry.)

'The Forest as a Resource.' (Commercial value of forest products, extent of their use, relation to other industries, significance in the United States.)

'The Forest as a Condition.' (Forest influences claimed and observed on climate, water-flow, health.)

'How Trees grow.' (A chapter of biological dendrology: the development and life-history of the individual forest tree.)

'The Mathematics of Forest Growth.' (Accretion and its measurement; quantitative and qualitative wood production.)

'The Evolution of Forest Growth.' (Development of forest growths as organisms, ecologic relations.)

'Timber Physics.' (Characteristics, properties and uses of wood.)

'Principles of Silviculture.' (The art of planting, reproducing and improving forest growths.)

'Forest Exploitation and Forest Protection.' (Tending and harvesting the forest crop.)

'Business Aspects of Forest Management.' (Forest survey, forest regulation and forest finance.)

'Forest Policies of Foreign Nations.' (The relation of the state to forest resources and how it has evolved itself in Europe.)

'Forests and Forestry in the United States.' (A brief sketch of forest conditions in the United States, and history of the movement to establish forest management.)

THE following table, originally published in the Baltimore *Sun*, gives the maximum temperatures during the months of July in several different cities:

Day of Month.	Eastport.	Boston	New York.	Baltimore.	Atlanta.	Cincinnati.	Chicago.	St. Louis.	Kansas City.	St. Paul.
1	82°	92°	98°	103°	90°	96°	92°	100°	100°	82°
2	72	94	98	103	86	92	86	96	100	84
3	80	96	94	97	90	92	84	98	102	92
4	76	72	86	96	92	92	94	98	104	82
5	72	70	90	94	90	92	90	100	90	78
6	60	66	82	96	90	88	86	96	92	78
7	62	76	84	90	86	80	66	84	94	74
8	64	84	78	77	88	78	68	86	98	78
9	60	64	80	83	88	82	88	92	104	90
10	62	82	80	85	88	92	102	104	100	84
11	72	86	84	87	96	100	70	104	102	84
12	76	72	72	77	96	88	76	102	104	88
13	80	74	76	73	90	88	74	96	98	98
14	84	90	82	82	90	90	78	90	102	98
15	92	90	86	89	92	96	84	98	102	94
16	74	94	86	90	90	96	92	96	100	92
17	68	84	84	89	88	96	92	100	100	92
18	68	90	88	90	84	90	76	98	100	90
19	78	78	88	93	86	90	78	98	102	94
20	76	82	86	90	90	94	96	100	104	102
21	68	90	92	92	90	100	102	106	104	96
22	86	94	90	93	90	106	76	106	106	94
23	74	80	90	94	86	94	82	106	102	100
24	68	90	90	93	90	100	94	108	106	104
25	70	66	74	94	92	94	88	98	100	84
26	72	68	70	74	98	98	84	98	90	74
27	72	76	80	74	92	100	96	98	92	74
28	66	72	78	90	90	96	90	98	84	84
29	66	66	92	96	92	98	86	90	86	82
30	58	86	92	95	92	92	84	92	90	80
31	61	88	80	87	90	88	80	92	90	80

ON or about September 1, 1901, the Bird Club of Princeton University will publish its first *Bulletin*, edited by Mr. Wm. E. D. Scott, curator of ornithology, Princeton University. It will contain an annotated list of the birds of Princeton and vicinity, by William Arthur Babson, B.S., 1901. This list is the result of four years of scientific observation and study of the birds of Princeton. The *Bulletin* will contain about seventy or eighty pages, will be plainly bound in paper and will be sold for one dollar.

THE Regents of the University of Colorado have ordered the publication of an annual to be called the 'University of Colorado Studies.' It will contain papers from the various schools and departments—the result of experiment and investigation during the year. The first number will be issued soon.

THE council of the Institution of Electrical Engineers arranged a fortnight's visit of the members to Germany, where the leading installations and establishments connected with the science and practise of electricity were inspected. The party was divided into three sections, the first of which visited Berlin only, whilst the second visited Berlin and Dresden, and the third Nüremburg, Frankfurt-on-Maine, etc., in addition to the foregoing places.

THE work of the new anti-toxine laboratory of the N. Y. Department of Health, the establishment of which was provided for by the late Legislature, has begun. The scientific part of the work will be done in a part of the Bender Laboratory Building, Albany. Dr. H. D. Pease, of the Sheffield Scientific School, has been appointed director. An animal house is to be fitted up near the laboratory so as to secure the most perfect hygienic conditions attainable for such purposes. It will house about fifteen horses for the manufacture of serum. The laboratory will supply state institutions with diphtheria and other anti-toxines.

SURGEON GENERAL WYMAN, of the marine hospital service, has sent to the supervising architect of the treasury a request that plans be prepared for a laboratory for the marine hospital service. Congress, by the act approved March 3, 1901, appropriated $35,000 for the buildings. A two-story main building and an animal house will be erected. The basement of the main building will contain heating apparatus, storage room for fuel, incinerator and store rooms; the first story will have one office room, library, quarters for attendant, rooms for the study of rabies, special investigating room, disinfecting room of 1,000 cubic feet and a room for micro-photography, with a dark room. The second story will have two special laboratory rooms, one office, animal room and two laboratory rooms of large dimensions. The animal

building, to contain apartments for animals, will be one story high, with loft for storage of food supplies; the interior of the walls and the floors to be moisture proof and to have ample water and sewer connections. Both buildings are to be lighted with electricity.

THE London *Times* quotes from the *Journal* of the Board of Trade, a report from the locomotive superintendent of the Oudh and Rohilkhund Railway, on the working of ten American Baldwin engines supplied to that line last year. After describing the changes made in the engines to suit them to local requirements, and the chief defects which have shown themselves, the superintendent concludes: "Those ten engines have been working passenger trains, running at 30 to 35 miles an hour, and goods trains, running at 20 miles an hour, chiefly the former, and they have done their work well. They steam capitally and are remarkably good starters; they get away from a station with 55 loaded (wagons or coaches?), equal to about 1,300 tons, with the greatest ease. They are a little higher in coal consumption than our new B class. They are easily repaired, but repairs will have to be kept up, as, if not, they will go to pieces sooner than our other engines would. They do not, as far as I can see at present, cost more in repairs than other engines, and I am very satisfied with them." The cost of these engines, turned out complete, was Rs. 42,020 each, and the cost of the new B class engine, which is the engine used on the line for similar work, is Rs. 44,826.

UNIVERSITY AND EDUCATIONAL NEWS.

MESSRS. MCKIM, Mead and White have been commissioned to draw up general plans for the future buildings of the University of Cincinnati. The University has recently received $25,000 to be applied to its engineering shops and laboratories.

AT a meeting of the University Court of Glasgow University on July 11, it was announced that under the will of the late Mrs. M'Roberts, of Todhill, a sum of £10,000 had been bequeathed to the University for the purpose of founding and endowing a chair as the court may direct.

THE University of St. Andrews has received, by the will of the late Miss Malcolm, the sum of £4,000 for the establishment of medical scholarships.

WILLIAM STOKES WYMAN, LL.D., was elected President of the University of Alabama at the last meeting of the trustees in June, 1901. Dr. Wyman received his education at Harvard University and at the University of Alabama, and has for many years been connected with the latter institution as professor of Latin. He has served the University as president *pro tem.* on several occasions in the past, and his election to the presidency meets the hearty approval of all the alumni and friends of the institution.

AT the University of Cincinnati, Professor Charles H. Judd, recently of New York University, has been appointed professor of psychology and pedagogy. Messrs. J. E. Ives, H. C. Biddle, E. F. Alexander and Wm. Baur, have been appointed instructors in physics, and Mr. Wm. Osburn instructor in zoology.

DR. S. S. COLVIN, Ph.D. (Strasburg), has been appointed assistant professor of psychology in the University of Illinois.

RALPH S. LILLIE, who this year received the degree of Ph.D. in zoology at the University of Chicago, has been appointed assistant in physiology in the Harvard Medical School.

HANNAH B. CLARK, Ph.D. (Chicago), has been made assistant professor of sociology in the West Virginia University, at Morgantown, W. Va.

DR. G. BREDIG, docent in chemistry in the University of Leipzig, has been called to an associate professorship in the University of Heidelberg; Giovanni Ossunna, chief engineer of the firm of Siemens & Halske, has been called to a full professorship of electrical engineering in the Technical Institute at Munich.

DR. MORITZ VON RUDZKI has been promoted to a full professorship of mathematical geodesy and meteorology in the University at Cracow; Dr. Ludwig Tetmajer, professor in the Zurich Polytechnic Institute, has been appointed full professor of engineering in the Technical Institute at Vienna.